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Articles

Diamonds in Finding and Fabricating Metals 358
E. D. LUCAS, JR.

Mounting of the 200-Inch Telescope—A Welded Structure—II 362
FRANK FREDERICKS AND N. L. MOCHEL

Metal Film for Motion Pictures 369
WALTER M. MITCHELL

Light-Weight "Alligator" of Aluminum Alloy 371

Copper-Zirconium-Cadmium Bronze 372
F. R. HENSEL, E. I. LARSEN AND A. S. DOTY

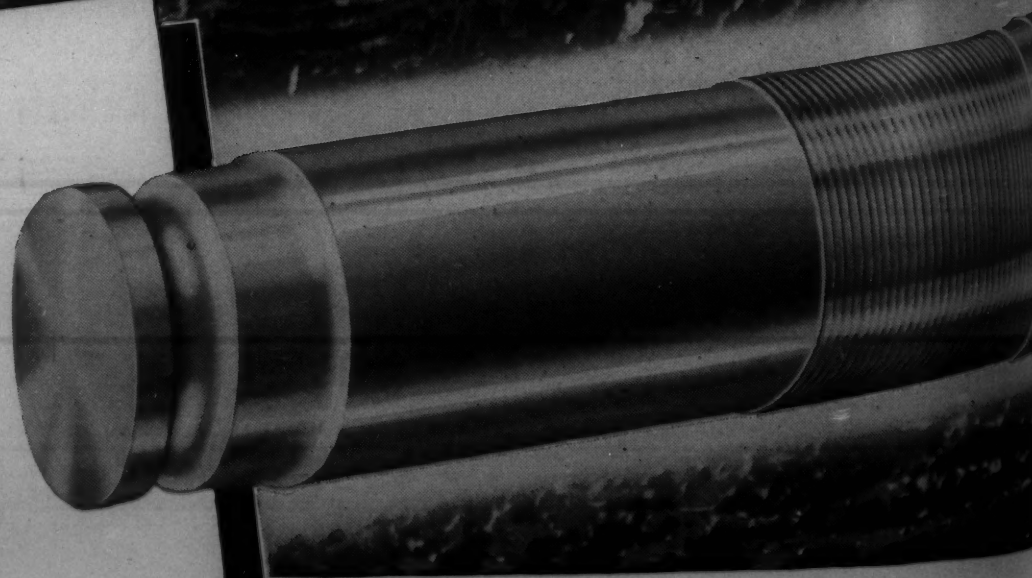
Fatigue Problems in Structural Designs—II 381
A. V. KARPOV

Manufacturers' Literature ..... A 10
Highlights ..... A 19
Editorial 357
New Equipment and Materials ..... MA 687
Books ..... MA 733
Current News ..... MA 734
Trends ..... MA 740

Metallurgical Abstracts

Reduction ..... MA 698
Melting, Refining and Casting ..... MA 698
Working ..... MA 701
Heat Treatment and Heating ..... MA 704
Welding and Cutting ..... MA 714
Finishing ..... MA 718
Testing and Control ..... MA 723
Metallography ..... MA 726
Properties and Applications ..... MA 727
Corrosion and Wear ..... MA 730

In the *Vital Parts*



U·S·S CARILLOY
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editorial

Bottlenecks

Editors of technical journals are taking up the cudgels on the side of those who argue that science and invention produce employment, by citing definite cases. We can't see the real necessity of proving that sort of thing to anyone who is intelligent enough to read a technical journal. Such editorials mostly waste their sweetness on the desert air.

However, if a really good case of a meritorious invention is needed, one cited by Holbrook in the June 3, *Saturday Evening Post,* fills the bill. He describes a trencher whose demountable parts can be packed on men's backs to the vicinity of a forest fire, set up and the trencher operated to produce a fire-stopping trench by mechanically hammering off the loose stuff from the forest floor. The machine, run by one man, is said to trench a mile an hour, or as fast as 300 men could clear such a trench. And when forest rangers commandeer workers for fire fighting, the workers don't take a W.P.A. pace, either. That the availability of such equipment in summer will save the all-winter jobs of many loggers is self-evident.

Other editors and writers take the benefits of technical progress as beyond the need of discussion and go on from there to the agreement that we need some new invention to produce something everyone will class as a necessity, once it is available. They clamor for invention, as though inventions can be produced on short order. Some argue on a purely statistical basis, citing figures to show that the number of patents per capita is not increasing as fast in the U. S. as in some other countries so we're going to the dogs on this count alone. In the first place, the patent offices of some countries merely act as recorders advancing practically every application to patent status and leaving patentability entirely to the courts, while others allow patenting of very obvious combinations of old elements, so that the number of patents issued is no real indicator of the number of true inventions. In the second place, the basic patents relating to any real industry-building development are very probably on the books already, if indeed, they are not expired or close to expiration, since there is a long period of incubation in such things. To ask for some new invention to save the immediate situation is to be a bit naïve.

Perhaps the type of invention to produce relatively rapid results might be exemplified by Canadian Patent 381630, "Appareil à faire des fossettes"—i.e. —a dimple-making apparatus. This works in a Goldbergian sequence: Girl makes dimples, dimples make her irresistible, boy can't delay marriage, new responsibilities force him to show enough ingenuity to find way to make living, he leaves ranks of unemployed, buys refrigerator, car, baby carriage, etc. Multiply by lots of dimples, girls, refrigerators, etc. and there you are.

If we stick to technology for our solution, why not focus attention on the bottlenecks that make things everybody already wants, too expensive for them to buy, or too inefficient or too short lived to justify the purchase? To cite again one of our favorite cases of technical improvement, the automobile tire, suppose everything else about the automobile could be made as it is today, but no one had been able to make a better tire than those of the days when one cost $25.00 and lasted 5000 miles. How many cars would be built this year?

We suspect that a good many industries are in the situation the car would be in without a tire to match the other parts in cost and service, without recognizing that a bottleneck exists. If some certain limitation that we have accepted heretofore as inevitable in the method of production or in the properties of the product could be removed over night, every operating man and every salesman could start out in the morning, certain that now he could go places.

If research activity is directed at these bottlenecks, some of them can be widened, and if enough are widened, that would turn the trick better than any hypothetical wonder-working invention.—H. W. G.

It Ain't Gwine to Rain No Mo'?

The last report of the Monsanto Chemical Co. remarks that orders have been coming in at a rate which suggests over-stocking, hence a corresponding diminution of demand is to be expected later. In other words, don't count on future dividends

(Continued on Page 390)

Diamonds in Finding and Fabricating Metals

by E. D. LUCAS, Jr.

423 *E. Union Boulevard, Bethlehem, Pa.*

IT MAY SEEM LIKE FANTASY to conjure up a connection between the crown of the Maharajah of Indore and a modern American automobile plant. But the Indian potentate's crown gleams brilliantly with its display of 73 diamonds, while the workaday cousins of those gems are grinding, boring and cutting in steel mills, in wire mills for copper, steel and tungsten, in automotive plants and machine shops.

Throughout industry, diamonds are no symbol of luxury; rather, they are a useful material, the hardest, natural or synthetic, known to man. Industrial diamonds, which may come from the same mine as the pure gem stones which sparkle from behind the jeweler's plate glass window, are destined literally to wear away their lives in service. About one-half of the world's diamond production is used for utility alone, in mining and manufacturing operations all over the world.

The vast majority of these workaday industrial diamonds are used in connection with metals and alloys. Diamonds are used in the prospectors' drills which locate ore mines. Diamonds are used for drawing fine, hard, precise wire. Diamonds are used in grinding, cutting and finishing operations on automobile motors, optical instruments and thousands of other products made of metals and alloys. Diamonds are indeed the crown jewels of industry.

Three Types Used Industrially

Three types of diamonds are used industrially. Gem stones are in the minority, and are clear and crystallized, like the "headlights" worn by Diamond Jim Brady. Bortz are the most common and popular industrial diamonds; they are round and imperfectly crystallized stones, with a radiate or confused crystalline structure. Carbonados, the third main group, are black diamonds, clusters of small diamond crystals in one hard lump without any cleavage planes. Carbonados are obtained in quantity only from the State of Bahia, Brazil, where they are found in streams and gravel beds along with gem stones. Bortz are mined principally in South Africa, although Brazil, the East Indies, India and other countries are also diamond suppliers.

These main categories of industrial diamonds, gem stones, bortz, and carbonados, are further subdivided into smaller classes. For instance, particularly fine bortz of a round form composed of crystals radiating from a common center are known as ballas.

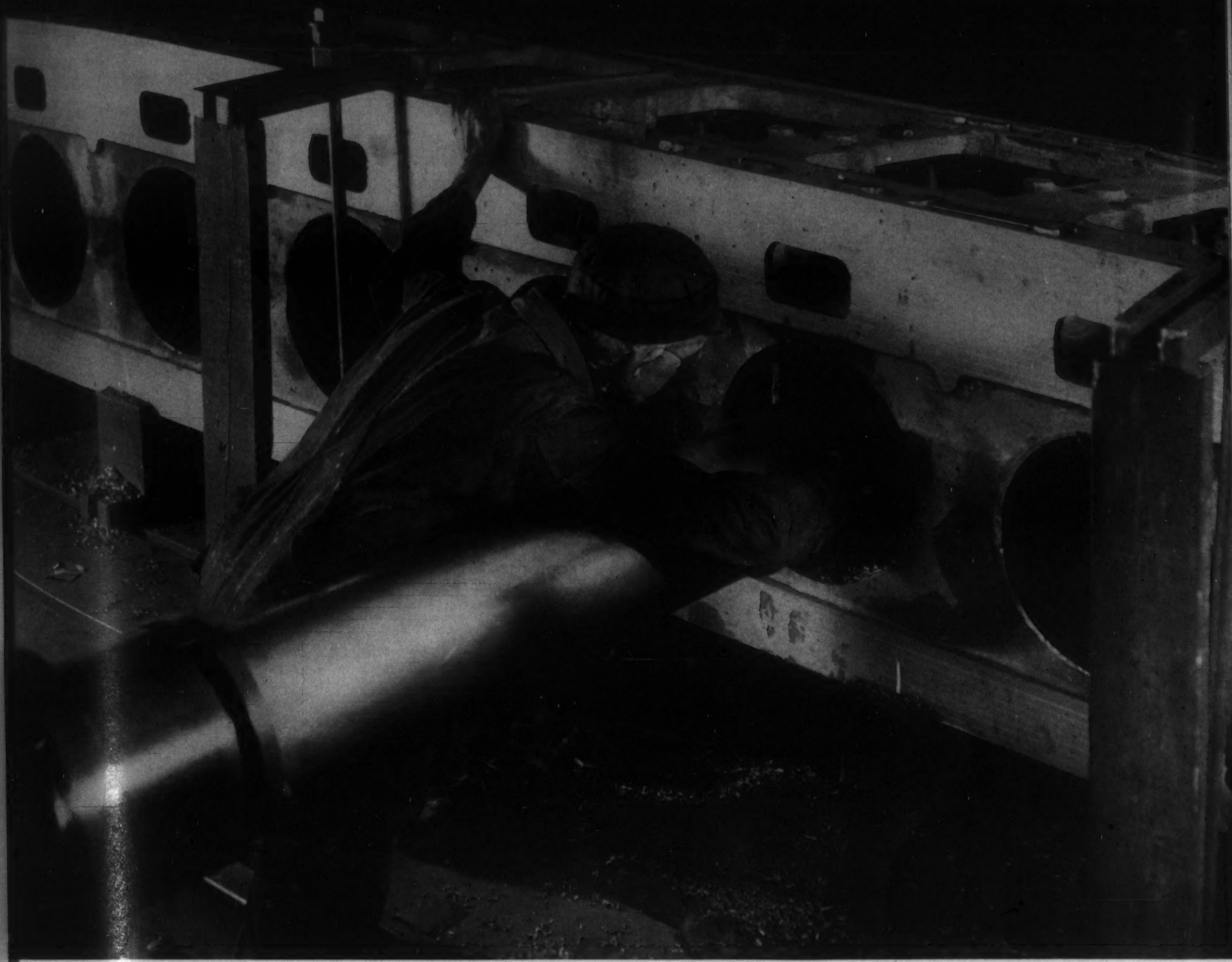
Diamonds are a useful prospector's tool. Right now, a thousand miles north of the copper mines at Butte, Mont., which were explored with diamond drills, there is a modern gold rush around the cabin town of Yellowknife on Great Slave Lake. There, in Canada's far Northwest Territory, the surface findings showed gold quartz so rich that it assayed half a million dollars to the ton. But in this remote wasteland, reached only by airplane or by a difficult 500-mile boat trip from the nearest railroad, it was important to know how deep and how rich were the gold strikes. Diamond drills were shipped by plane to tell the answer.

These diamond core drills consist of diamond bits, rings of a special alloy into which are set a hundred or more small bortz diamonds, attached to the ends of tubular steel drills. The drills are rotated by power, and the diamond core bits cut through quartz and granite, rock tough enough to crumple the hardest steel, bringing back samples or cores of the strata below. Then mining engineers can analyze these samples to discover whether a strike is just a surface outcrop or a rich, deep vein of ore.

In the Mining Industry

At Yellowknife the results were so favorable that 30 mining and prospecting companies are working in this area, thanks to the assayed samples from diamond core drills.

In the province of Ontario, statistics have been collected on the use of diamond drills. They show



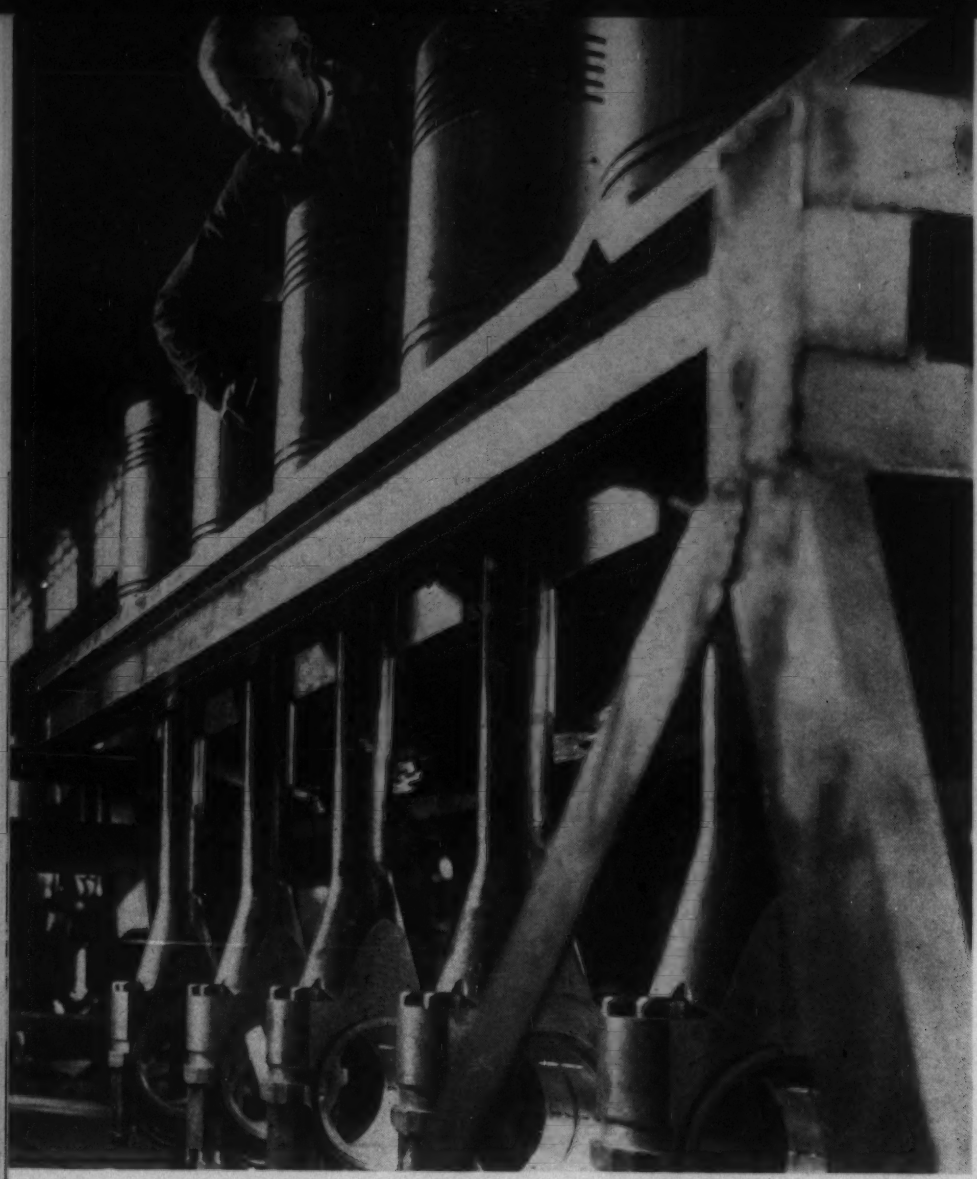
The efficiency of a Diesel engine depends on the accuracy of the machining of the cylinder block. Diamond sharpeners keep the cylinder boring tools keen and accurate.

that in this area alone about 350 miles of drill holes were bored in 1936 with diamond core drills. Drillers used about 100,000 carats of industrial diamonds, largely bortz such as the "Finehards" supplied by J. K. Smit & Sons, varying in size from 1/30 to ¼ carat. A typical mine explored with diamond drills is that of Falconbridge Nickel, near Sudbury, Ontario. There the ground was covered with gravel to a depth of 60 ft. About 90 holes were bored, for a total length of 18,000 ft., outlining an ore zone 7,000 ft. in length. With no information other than that provided by the cores brought up by the diamond drills, a shaft was sunk and a successfully producing mine brought in.

One of the most exciting mine rescues in recent years was made possible because of a diamond drill. In the spring of 1935, three men were trapped far underground in the Moose River Gold Mine cave-in. A diamond drill was used to sink a small shaft for sending down food, drink and medicine. This shaft was drilled so accurately that it came within 6 ft. of the men, over 150 ft. below; and the supplies sent down to them kept them alive until the rescuers reached them.

In Precision Tools

Diamonds were used in mining many decades ago, but the use of diamonds in the precision tools used in machine shops dates back only to about 1914. In the war years, Liberty motors for airplanes became such a necessity that diamond boring of metals was developed in a more or less crude way to fill the gap left by ordinary machine tools, where tolerances required the precision that only diamond-tipped tools can give. Liberty motors had seven bearings, and to align them was a tremendous problem. Various types of bars and reamers were used with no great success. It was probably Nordyke-Marmon who first conceived the idea of using a diamond tool to finish-bore these seven bearings. Later Packard and Cadillac adopted this diamond method for the motors which



Inspection of Diesel engine pistons and connecting rods after a new engine has been given a test run in the plant of a leading Diesel builder. Diamonds help to make these pistons set perfectly. (Courtesy: Gulf Refining Co., Pittsburgh.)

A Diesel engine piston is being ground for accurate measurement and smooth finish. This grinding wheel takes off only a small cut. This and other grinding wheels are trued with the aid of diamonds. Some grinders use a lap of diamond dust and oil for cutting. (Courtesy: Gulf Refining Co., Pittsburgh.)

they were building. Nordyke-Marmon continued to use shaped diamond tools for machining auto parts after 1918, and both Cadillac and Packard had machines designed for their diamond boring operations. At present all the principal automotive manufacturers use diamond-tipped tools.

These shaped diamond tools consist of a diamond set in a metal holder. The diamond point is carefully cut by a skilled craftsman. First, the shape of the diamond is magnified up to 75 times by means of a projectograph, and this instrument is again used for checking the final dimensions, included angle and radius of the stone. Then the diamond cutter cuts or polishes the table or flat part of the stone. The proper undercuts are next cut or polished on the right and left sides of the stone, to give the diamond the desired included angle and the proper clearance on the cutting edge. The radius or rounded cutting edge is formed and polished as the final step.

In the Automobile Industry

In a typical automobile plant, these shaped diamonds set in metal holders are used to finish wrist pin holes in pistons, to ream bearing ends of connecting rods, and to turn aluminum alloy pistons and other parts. The Ford Motor Co., for instance, regularly uses diamond-tipped tools for boring wrist pin holes in rough and finished pistons, for boring bearing holes on both large and small ends of connecting rods, and for turning pistons.

In making Plymouths, like other automobiles, hundreds of shaped diamond tools are used. To keep track of these many diamond tools, there is a special "diamond clerk" who checks them in and out, as the tools are borrowed for precision drilling, fine surface finishing, truing other tools, boring wrist pin holes, etc.

Another familiar use of industrial diamonds is found in the Studebaker plant at South Bend, Indiana, where stones of two and one-half carats are regularly used to dress down the abrasive wheels used in grinding crankshafts. Here indeed is one of the most widespread applications of the industrial diamond, because in factories of all sorts in every country, diamonds are used for truing grinding wheels. In this use, about 85 per cent of the diamonds employed are of the bortz type, while the remaining 15 per cent are carbonados.

Both shaped diamond tools and resinoid wheels impregnated with diamond dust are used in truing grinding wheels. The shaped diamond tool usually adapted to this purpose has a rounded cutting face which is made to travel across the wheel face at a very slow and uniform rate. By combining a light cut and a slow traverse, the diamond point keeps fairly cool and its life is prolonged. By changing the depth of the cut or the speed of the diamond

in traversing the face, an operator can easily make the wheel surface either rough or smooth.

In Machine Tools

Diamonds have several advantages as points for machine tools. Whereas ordinary cutting or grinding tools soon wear down, shaped diamond tools consistently set amazing records of performance because diamonds are by far the hardest substance known. In one large automobile plant, for example, a shaped diamond has been used to ream over 19,000 bearing holes. The diamond has been reshaped and reset several times, and is still doing precision cutting. Another automotive manufacturer reported a run with a single diamond tool which machined wrist pin holes on over 200,000 pistons before the diamond was chipped and needed relapping.

A second reason why industrial diamonds are becoming increasingly popular, especially among those who have to bore, finish or grind metals, is that a diamond cutting edge gives a precision in boring or turning operations that no other substance will give. Diamond-tipped tools are suited to mass production, the precise finishing of thousands of identical parts. The Bausch & Lomb Optical Co., maker of precision instruments, is a large user of industrial diamonds, because its production men find that a shaped diamond tool, properly handled, will machine several hundred thousand parts without need for relapping.

Diamond tools have been used to turn all sorts of metals, from soft babbitt to hard bronze, with accuracy often to one ten-thousandth of an inch. Aluminum alloy pistons were machined with great difficulty before shaped diamond tools were used to turn them. Diamond-tipped tools may occasionally chip after limited use, but only when proper precautions have not been observed as to the holder, the set of the tool, the operating speed and the coolant.

In Wire Drawing

Precision is the chief factor in another application of diamonds in the metal-working industries—wire drawing. About one-fifth of all industrial diamonds are used as dies for drawing fine wire of copper, steel, tungsten, osmium and tantalum. This use dates back to the first patent on a diamond die, issued to Brokedo in England in 1819. The stones used are cleavage plates or thin crystals, the so-called "flats," and ballas. Their weight varies from ½ to 10 carats. In each stone is drilled a hole at dead center. The hole is tapered at each end; it is started with a diamond point and is finished with a steel drill fed with diamond dust. When the hole is completed the diamond plate is mounted in a metal disc, and then wire is drawn through a series of such dies until it is reduced to the proper diameter.

When the aperture of one of these diamond dies grows too large, after much wear, it is redrilled to draw the next larger gage of wire. Diamond dies last a long time, however; enough 20-gage copper wire to go around the world 25 times can be run through a diamond die before the hole suffers any measurable enlargement. And diamond dies must be precise, for some of the filament wires drawn are only 0.0004 in. (0.01 mm.) in diameter; a rod of tungsten 3 in. long and ⅜ in. in diameter, is transformed by diamond drawing into a gossamer filament 58 miles long!

Heavier gages of wire are often drawn through dies of the hard synthetic material, tungsten carbide. When these dies develop worn areas or rings after hard service, another form of industrial diamond, diamond dust, is used with oil as a lapping agent in connection with grinding tools which smooth out the worn spots. These diamond-lapped grinding tools, as well as metal saws which are fed with diamond dust in an oil bath or have the gem dust beaten into the cutting edges, find many uses throughout industry. Diamond-lapped saws, for instance, are often used to cut stainless steel bars.

In Hardness Testers

It is not surprising that a diamond, which lends itself so readily to precise work throughout the metal-fabricating industries, finds a useful place in metallurgical laboratories. Hardness testers, Rockwell, Vickers and others, employ the principle of a machine which forces a diamond point into the metal under examination. A dial on the instrument gives a reading for the depth of penetration of the diamond point, from which in turn may be calculated the hardness of the metal tested. The Nestor Johnson Mfg. Co. has capitalized on this test, which it uses to determine the hardness of steel runners of ice skates, as an effective advertisement, while the American Safety Razor Co. has also advertised its product as diamond-tested.

Diamonds are used to scratch designs on metal cigarette and vanity cases. Diamonds serve as nozzles on oil-burning furnaces and Diesel engine injectors. A new machine for boring cylinders of Diesel engines includes a diamond sharpening disc for keeping a keen edge on the cylinder cutters. Diamond-tipped tools are used to finish bearings for electrical motors, automotive valves, bronze bushings for refrigerators and the precise parts of watches, cameras and all sorts of precision instruments and apparatus, large and small.

As metals and alloys are manufactured in continually more efficient and attractive forms, industrial diamonds are playing their increasingly important role in helping to find and fabricate metals.

Mounting of the 200-Inch Telescope

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A Welded Structure

PART 2 · CONCLUDED FROM NOVEMBER

by Frank Fredericks and N. L. Mochel

Resident Engineer for California Institute of Technology, and Metallurgical Engineer Respectively, Westinghouse Electric & Mfg. Co., South Philadelphia Works, Lester, Pa.

The most spectacular piece of fabrication in the whole telescope mounting is no doubt the horseshoe girder or "horseshoe", having a total weight of 155 tons not including the counterweights to be filled in later. A view of the floor assembly, with the north side up, is shown in Fig. 18.

It is constructed in three sections with machined joints, the bolts to be shrunk in with the aid of electric heaters. The two outer sections, or "horns" are provided with ring faces or flanges, to which are bolted the tubular yoke sections. There are also faces for the attachment of the 2-ft. tubular struts shown in Fig. 2. The outer or track plates were 4½ in. in thickness to allow for machining later, and were received from the mill very closely formed to the required radius. The inner plates are 4 in. thick.

Fig. 19 shows a pair of these plates set up on edge around a web plate. This latter was cut with a radiograph machine, with a single bevel all around, facing the outside. Fig. 20 shows an early stage of fabrication of this horn section, while Figs. 21 and 22 show a later stage of the same piece and the center section respectively.

The arrangement of the 1⅛-in. transverse stiffening ribs along the inside of the track plate calls for some comment. Referring to Fig. 20 these

Fig. 18. Assembly of Horseshoe Bearing.

Fig. 19. West Horn of Horseshoe—First Step in Fabrication.

plates are spaced about 12-in. apart by short sections of the central rib. In making this assembly, the cumulative pull of the welds between the rib sections and diaphragms had to be guarded against. This was done by first tacking them in place and to each other in groups, removing each group for welding on the floor and then replacing it for final welding inside the track plate. By proceeding in this way, the final out-of-roundness of the three horseshoe sections when bolted together as in Fig. 18, before machining the circumference, was found to be not more than plus or minus 3/16-in. on a diameter of 46 ft.

All the diaphragms or stiffening plates in the horseshoe sections were planed to an exact width so as to obtain a good bearing against the cover plates. This obviates the filling in of gaps which would be left if the plates were torch cut and consequently varied in width.

The end panels of the three sections are identical. A close-up view is shown in Fig. 23, and one of them is also clearly seen in Fig. 22. Each panel or frame consists of two long 3-in. plates, a 6-in. and a 7-in. slab, with a ¾-in. plate in the center. It was originally intended to weld these parts one by one into the main structure, and single bevel welds were shown on the drawing to connect the ¾-in. web plate to the frame. However, it was found more desirable to complete these panels as separate subunits. In making the above bevel welds, shown in Fig. 24 (a), some trouble was experienced in the bellying of the web plate and consequent cracking along the edges. The web plates were then changed to call for double fillet welds as shown in Fig. 24 (b).

All the inside welding was completed with the north side cover plate left off. Braces of 4-in. double extra heavy pipe were temporarily welded across the edges of the inner and outer plates to hold the structure during welding and the first annealing operation, as shown in Figs. 21 and 22.

The horseshoe sections, like all other parts of the mounting, were to be thoroughly sandblasted and painted inside and out. In order to avoid the difficulty and danger of sandblasting inside these hollow structures after completion, the plan was adopted of cleaning all inside surfaces after the first anneal, while one side was still open, and coating them

Fig. 20. West Horn of Horseshoe—Assembling Stiffening Diaphragms.

with a high temperature resistant aluminum paint before attaching the cover plate. All inside welding was then done with the aid of a shiphold ventilator for withdrawing the fumes from the operator. After the second anneal, very little cleaning with a grinding wheel or revolving wire brush was found to be necessary.

The arrangement of the welds joining the 4½-in. track plate to the end panel or connecting flange is seen in Fig. 25 (a) and Fig. 26. The first detail (a) shows the method employed at the start, the inside weld being made first. Both sides were welded in a vertical position. During preliminary planing of the joint faces, later on, it was found that there had been a lack of penetration and some cracking in a number of places in the large outer welds. To play safe, therefore, the deposited metal was removed entirely by milling, as in Fig. 25 (b). Each section was then set in a pit to bring the face horizontal for downhand welding. The metal was deposited rapidly, building up short sections at a time and peening each layer. Heat was applied with gas torches around the work and maintained until the sections were once more placed in the annealing furnace.

After machining the end faces, the new welds presented a very homogeneous appearance, and etching showed a total absence of imperfections.

Fig. 21. West Horn of Horseshoe—Ready for First Anneal.

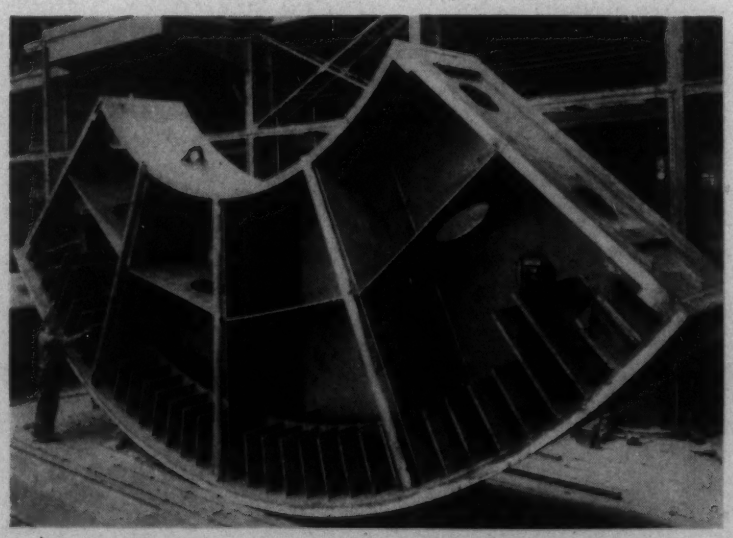


Fig. 22. Center Section of Horseshoe—Ready for First Anneal.

Fig. 23. End Panel of Horseshoe Sections.

The upper and lower sections of the side members of the yoke are in the form of tubes 10 ft. 6 in. in diameter and approximately 17 and 19 ft. long respectively. They are connected by internal flanges 2½ in. thick. One of these tubes is shown in Fig. 27. Each is formed of two rolled shells of 1-in. plate with a longitudinal and a circumferential seam welded in an automatic welding machine. The flanges were first rough turned for the welding groove as shown in Fig. 28. The original intention was to make the outside weld only. It was found however that the contraction of the weld had the effect of dishing the flange quite appreciably. The inside fillet weld shown in the illustration was therefore made first to counteract this effect.

The center section of the yoke is in the form of a similar flanged tube or 1-in. plate, 10 ft. long, into which is set a transverse cylinder 5 ft. in diameter, with reinforcing plates around the opening. Into this transverse hole will be inserted the ball bearing unit for the declination axis, about which the telescope tube rotates in the yoke.

The particular center section at the west side of the yoke, which is shown in Fig. 29, is provided with a large bracket which will take the thrust of the worm driving a 14-ft. worm gear for rotating

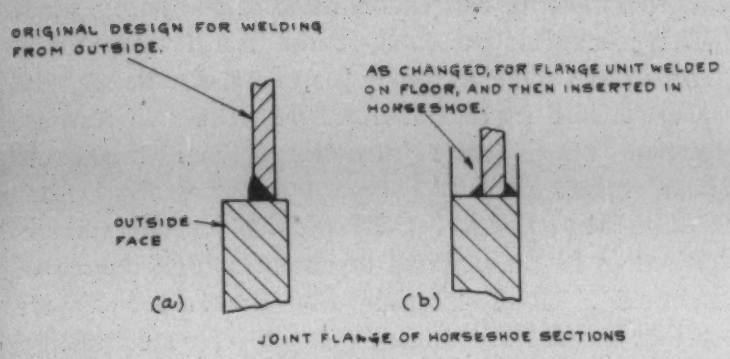


Fig. 24. Welds on Horseshoe End Panels.

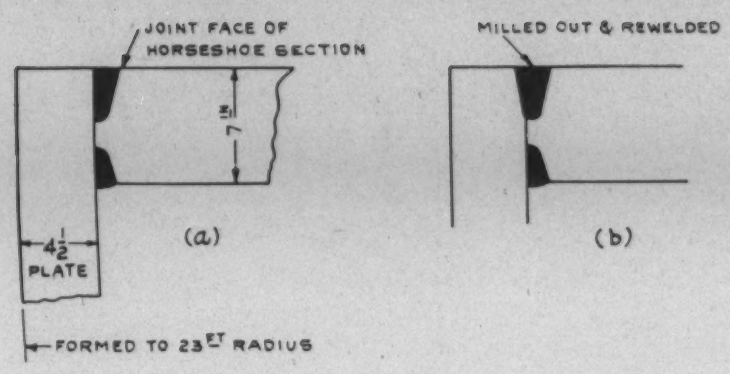


Fig. 25. Main Welds of End Panels to Track Plates of Horseshoe Sections.

the telescope tube. This piece is noteworthy for the number of irregularly shaped plates composing it. It is a good illustration of the versatility of the welding art, in conjunction with torch cutting, in building up pieces of awkward shape without spending a great deal of time in the making of drawings of the parts. In this particular case, the individual plates were carefully projected on the drawing board, taking their thickness into account. However, a few trial templates showed that they were not very reliable, due probably to slight misplacements and changes of shape in the parts already welded. Each plate was therefore made to a sheet metal template trimmed to the required shape as the work proceeded. Most of the bracket plates were attached to the main piece by bevel welds from the outside.

The south cross member of the yoke is a box structure 46 ft. long having two large flanges for attachment of the tubular yoke sections and four flanged nozzles to which the brace pipes are attached. Fig. 30 shows the completed structure on the planer. Its finished weight is 86,000 lbs.

The center unit of this piece is shown in Fig. 31; comprising two 4-in. plates, a central shell, and various stiffening diaphragms of ⅞-in. plate. Here again some ingenuity was required in arranging the sequence of assembly of the plates in order to do all the welding from the outside. The pipes at the right are conduits for electric wiring.

The inside surfaces of the plates were sandblasted and coated with the high temperature resistant paint before assembling for welding. This was also done for the plates and stiffening channels seen in the view of the half completed structure shown in Fig. 32.

In the final stages of welding, the cross member was reinforced with H beams tying the two large flanges together with supplementary bracing between the beams and the center section. This reinforcement was very effective in holding the shape of the piece while turning it into various positions for welding, and also to prevent spreading and sagging while annealing. By careful fabrication and making allowance for shrinkage, the center line distance of the two large flanges was held to a final tolerance of ⅛ in.

As mentioned previously, the south bearing of the telescope mounting consists of a 7-ft. spherical

Fig. 26. Original Welding of End Panels to Horseshoe Sections.

Fig. 27. Tubular Yoke Section.

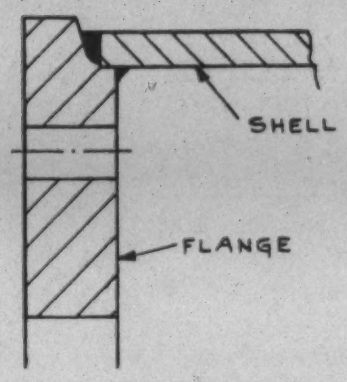


Fig. 28. Welded Joint of Yoke Tube Flange to Shell.

Fig. 29. West Center Yoke Section.

journal bearing carried on three self-aligning shoes. The journal is attached to the north face of the south cross member by means of a large flange, and projects into its central hole. The shoes in turn are carried on brackets projecting from the south bearing box girder.

The hemispherical shell of the journal was required to be well ribbed to obtain a high degree of stiffness. These internal ribs introduced a very serious menace to securing a single piece steel casting of required soundness. It was therefore decided to build up the journal of two separate castings and a large number of ribs welded together. The hemisphere was obtained in the form of a plain shell or bowl casting 4¼ in. thick, made without ribs in order to ensure sound metal. It was first rough machined over the external surfaces. Sixteen ribs of 1½-in. plate were then welded into it. It was next annealed, bored and faced on the ribs, and turned on the edge for a welding groove.

In Fig. 33 is shown the bowl with its welded ribs, ready to be placed on the rough machined flange for welding. This was done with the flange in a horizontal position, with the application of gas burners in the central hole, by two welders working on opposite sides as rapidly as possible. The piece was kept hot up to the time of its transfer to the car of the an-

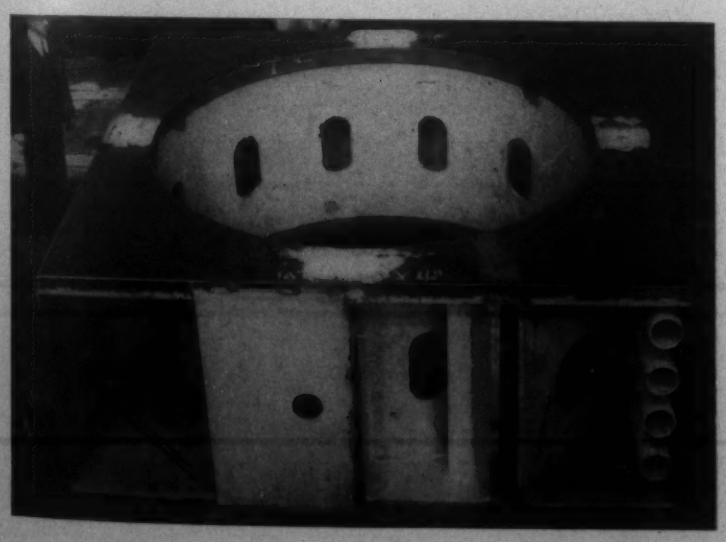
Fig. 30. South Cross Member.

nealing furnace. The final step was to weld pieces of plate lengthwise on the ribs so as to completely enclose the pockets between them and thus form a very rigid structure, as shown in Fig. 34. Each of these welds was to join two plates with the supporting rib in the shape of a letter T. This was a problem of some difficulty, on account of the extreme likelihood of shrinkage cracks due to the rigidity of the parts. A test was made with three plates of the same thickness, freely supported to form a T, and the shrinkage was found to be sufficient to pull the two lateral plates 12 deg. out of their original position. The problem was then solved in the manner shown at the right of Fig. 34. Each cover plate was milled lengthwise with a slot having a fillet in the bottom and was then slightly bent in a press to the approximate radius of the circle on which they were to lie. The welds were then made without difficulty and without the application of heat, using a hot A.C. arc with a current of 500 amperes.

Fig. 35 shows this final operation. The plate and bracing attached to the small end of the ball was temporary only, and enabled the piece to be rolled on the floor in the manner of a spool for downhand welding. The slots in the plates are clearly seen behind the welder. They were left open since no question of strength was involved. A ¼-inch vent hole was drilled in each plate to allow the air in the pocket to expand during the final annealing operation, previous to machining. The finished weight of this spherical journal will be 27,000 lbs.

The south bearing shoes mentioned above are carried on hardened support discs or buttons inserted in holes bored in and near the ends of the three brackets shown on the front of the box girder, Fig. 37. These three brackets were torch cut from 16-inch slabs, planed along their three sides, and welded to the box girder. Inasmuch as each of the shoes will carry a load of 160 tons, the weld at the toe of the bracket joining it to the central barrel forging is a very important one. The manner in which the

Fig. 31. Center Section of South Cross Member.



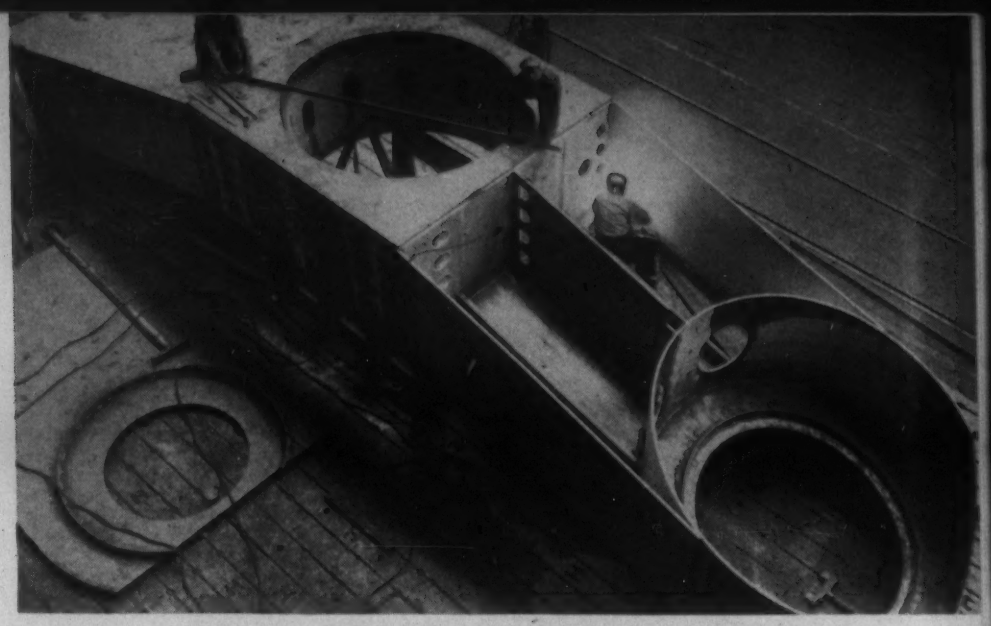


Fig. 32. Fabrication of South Cross Member.

Fig. 33. Fabrication of Spherical Bearing.

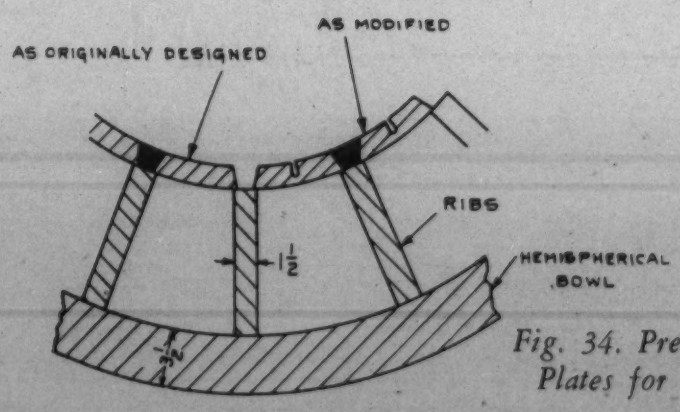


Fig. 34. Preparation of Closing Plates for Spherical Bearing.

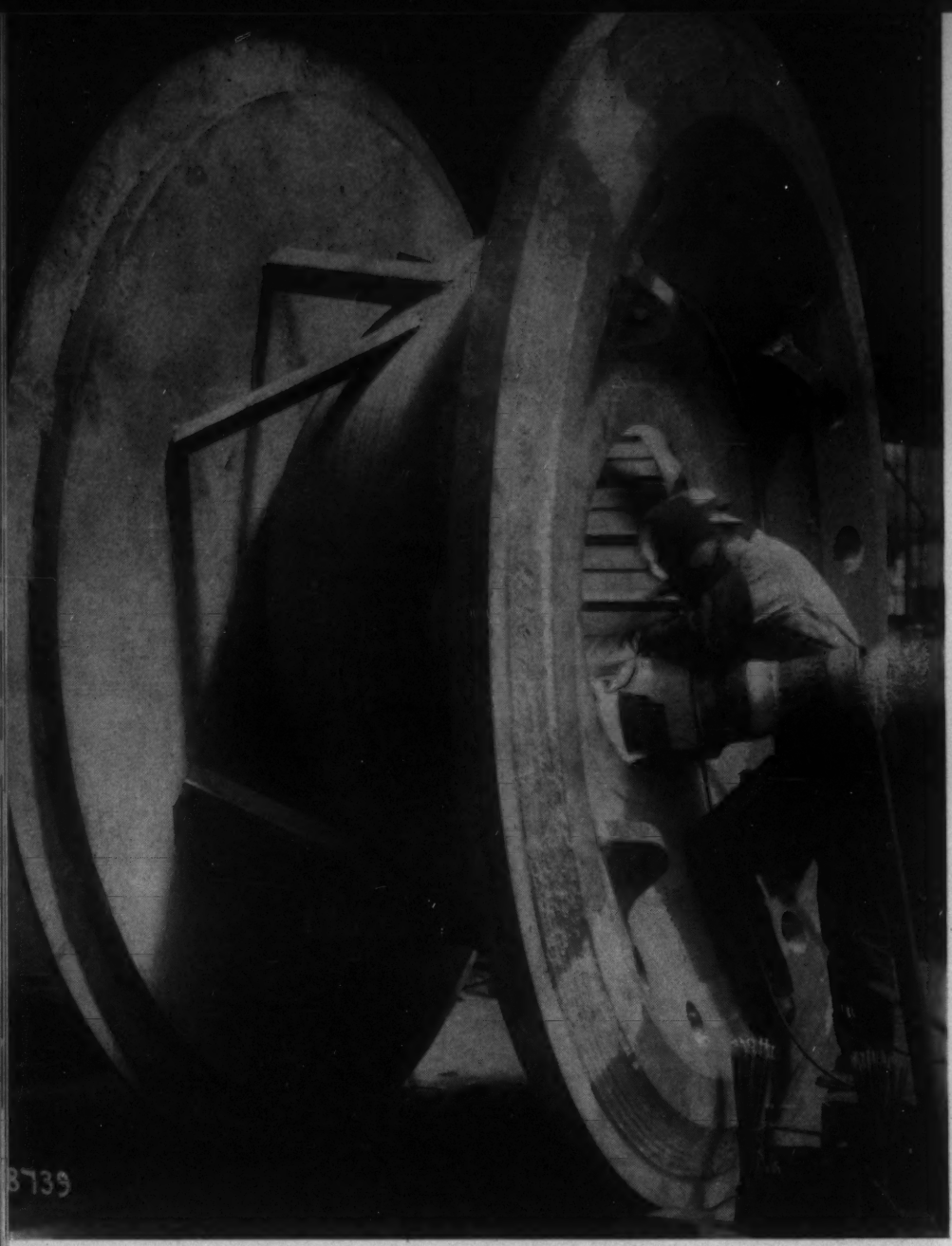


Fig. 35. Final Welding of Spherical Bearing.

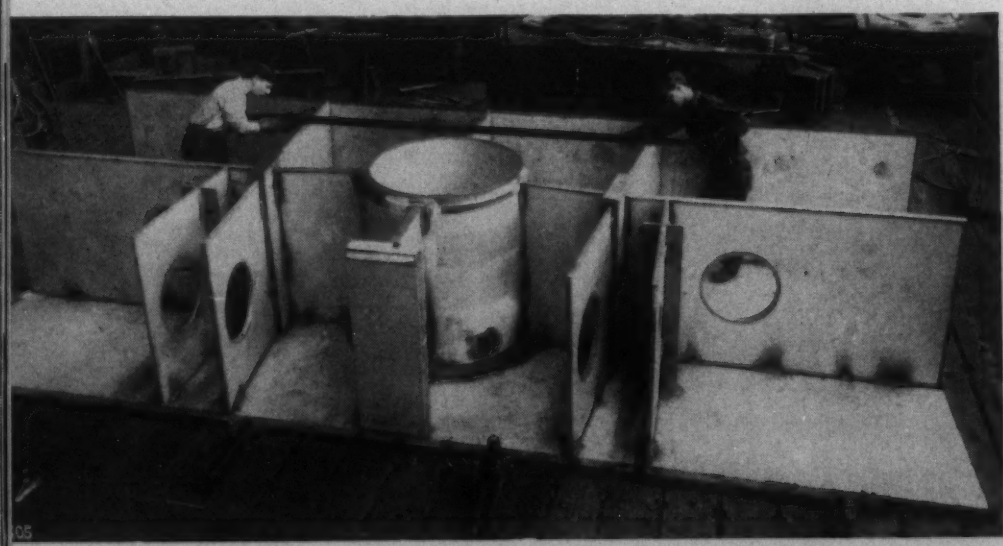


Fig. 36. Fabrication of Box Girder.

Fig. 37. Box Girder—View from North Side.

various welds were made is shown in Fig. 38. Heat was applied to the brackets while making these heavy welds.

The first stage in the fabrication of the box girder is seen in Fig. 36, the 2-in. plate forming its south side being clamped to the floor. The 1-in. top, bottom, and end plates were machined with the welding grooves seen at the bottom of Fig. 38. The various diaphragm plates were planed on edge to an exact width to ensure a good bearing against the back and front. The whole group of plates was sandblasted and coated with the high temperature paint on their inside surfaces except at the edges where they were to be welded together, as seen in Fig. 37. The box structure was first completed without the bearing brackets and then given a preliminary anneal in order to relieve the stresses in the welds around the ends of the barrel forging. The second and final annealing operation was performed after all brackets, feet, and lugs were welded in place. The box girder as completed weighs 70,000 lbs.

Conclusions

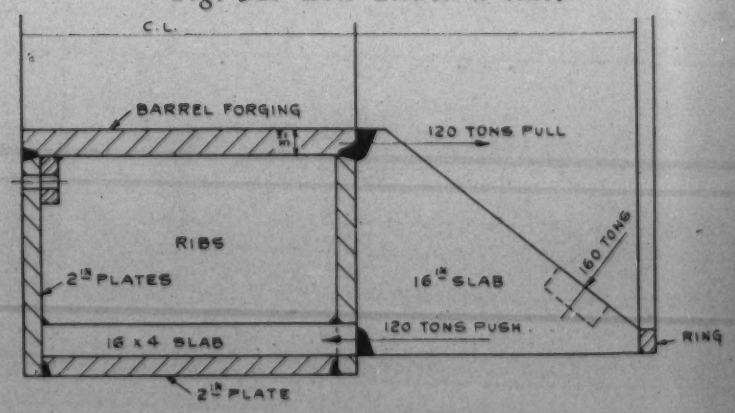
It would have been extremely difficult, if not impossible, to have constructed the mounting for the 200-in. telescope by other means of fabrication than arc welding. The art of welding influenced the basic arrangement, permitting a design that met the general requirements better than any other.

From the manufacturing standpoint, only the two items of trouble referred to above were experienced, and these were quickly overcome, each in a first corrective move. Based on long experience with all methods of fabrication, and also considering the size of the parts under discussion, the record of the welding art as a means of fabrication on this project is excellent. No other fabricating method could have been so free of trouble.

In accuracy of work, several examples have been given to show that uniformity and freedom from distortion can be realized even in large pieces with welded construction.

The 200-in. telescope will stand as a monument to the welding art for many years to come.

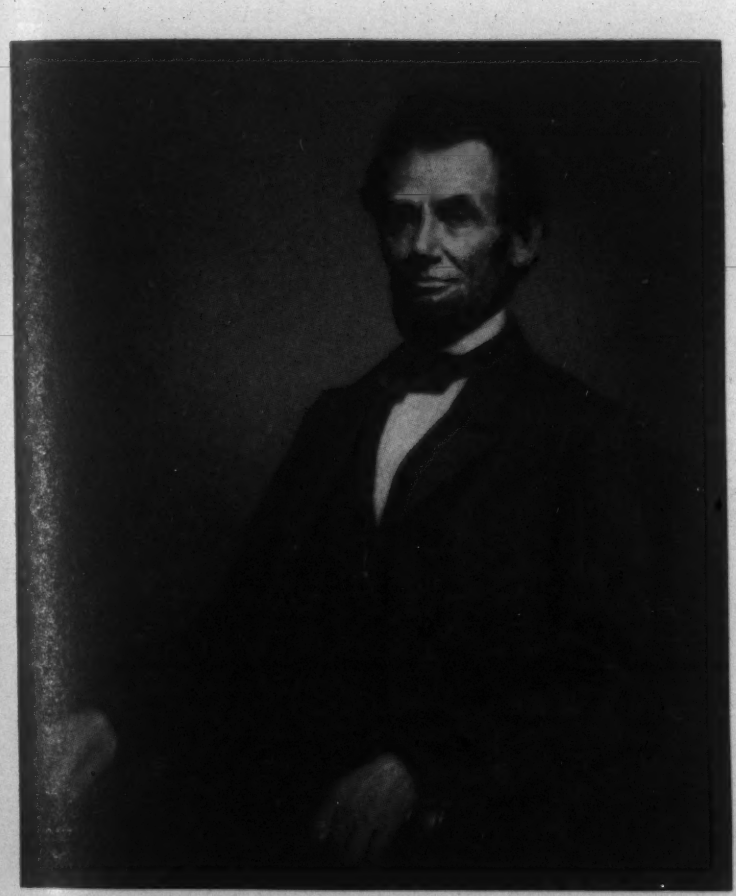
Fig. 38. Box Girder Welds.



Metal Film for Motion Pictures

by WALTER M. MITCHELL

Metallurgical Engineer, Westfield, N. J.



A Reproduction of the Bradey Negative of Abraham Lincoln Made 26 Years Ago on Metal By One of the Carter Processes.

A NEW APPLICATION FOR METALS that has aroused considerable interest in motion picture circles is the use of very light gage metal strip as a base for motion picture film in place of the conventional cellulose. This development is the result of exhaustive research by Dr. Robert W. Carter of the Taylor-Sloane Corp. of New York. The strip used is an aluminum alloy containing about 92 per cent aluminum. While other white metals would be suitable, especially 18 and 8 stainless steel, if they were available in sufficiently light gages and with highly reflective surfaces, so far the aluminum alloy, which has been a special part of the development, is the only metal which meets the requirements.

This strip is used as a base on which the sensitized emulsion is coated—the emulsion and the coating process being a part of the development. Sensitiveness of the film to light is such that the printing time will vary from 1/100 to 1/2 second in standard photographic printing equipment. Development and fixation are carried through after exposure with the ordinary photographic chemicals and present no variation from customary procedure, with the exception that as the metal film is non-absorbent, the time required for these operations is much shortened—an important advantage. Actual tests showed that development, fixation, and drying together with handling and printing of a positive required only 4 min. for the completion of all operations. One important characteristic of the metal film base is the remarkably fine grain obtained, even with the ordinary metol-hydroquinone developer. The chemicals used are apparently without any effect on the metal film itself.

The great advantages of the metal film base are its permanence and the complete elimination of the fire-hazard, since the metal film is absolutely fire-proof. This latter feature should save the motion picture industry thousands of dollars in insurance rates and storage costs; and, it would seem, reduce the cost of installation of projection equipment since the fire-proof booth will no longer be necessary.

Metal film, or rather strip, of the 92 per cent aluminum alloy can be produced 36 in. wide in gages as light as 0.003 in. with proper equipment. Tests have demonstrated that it will withstand repeated bending, as required in passing through the projector, without fatigue or becoming brittle. It is expected that sensitive metal film of this width will be available for slitting into narrower widths when developments are finally completed. Sensitized sheets, and plates, of the aluminum alloy or other metal, will also be available in sizes up to 8 by 10 ft., and in gages up to 1/4 in.

Only slight modifications in handling and in projection equipment are required in using the metal film, which can be used for the original negative as well as for the positive for projection purposes. Owing to the white color of the aluminum alloy and the special processing it receives, it has very high reflectivity. Tests by an independent laboratory show a reflectivity factor of nearly 90 per cent against a transmission factor of about 77 per cent for the ordinary exposed and developed cellulose film. Printing and projection of the positive film are necessarily done by reflected light.

Regarding the question of the reproduction of sound for "talking pictures," the sensitized metal

film is admirably adapted for this. Actually an accurate photographic sound track on a smooth fine grained highly reflective surface is a finer medium for sound reproduction than if on cellulose. In the cellulose film the light is scattered in various directions while passing through the cellulose stock, and this may give rise to background noises and blurring of sound. With the metal film the light of the exciting lamp is concentrated on the sound track at 25 deg. incidence. It then passes through two condensing lenses to the photo-electric cell, and the balance of the sound system is standard equipment.

While more details might be given regarding the equipment necessary for exposing the film and projecting the pictures on a screen, enough has been said to demonstrate the usefulness of the metal film base for motion picture work. In regard to costs, it is confidently expected that the price of the metal film will not exceed that of the cellulose film, with the added features of greater strength, permanence, and non-flammability.

To those interested in permanent records the metal film offers decided advantages. Images that are fully permanent can be recorded on both sides of the film, and with the fine grain produced this means that the reproduction of books, documents, and records can be reduced to a very small space. For instance, the Encyclopedia Britannica with its 25,000 pages 8½ x 10½ in., weighing 126 lbs. and occupying a space of 4036 cu. in. can be micro-filmed on metal strip to occupy 30 cu. in. and weigh 6 lbs.

One of the advantages of photography on metals is permanence, and this is highly important when the recording and preservation of documents is concerned. Paper prints, even when made with the greatest care are uncertain at best, even with careful storage, and their inflammability is well known. Photography on metal strips, or sheets, whether of aluminum alloy, 18 and 8, copper, or other metals, offers many advantages and is still in its infancy. It has application for commercial or artistic purposes in advertising, architecture, and the manufacture of novelties. The natural lustre and brilliancy of the prepared metal surface give a life and vitality to the finished picture on metal which is not obtainable with a dead white medium like paper. With the many finishes available on metals and with the colors obtainable, reproductions of great beauty are easily producible, and should find extensive use for science, engineering, advertising, and decorative purposes.

A Few Chuckles

Hot Steam!!

To the Editor: From a booklet published by a large electric company—

"In a tenth of a second steam hot enough to melt ordinary steel is changed, in a turbine like this [pictured], to water too cool to bathe in [! ! !]. The heat energy has been consumed in turning the turbine rotor."

J. M. D.

To Harden Steel

To the Editor: The following item taken from the *Popular Science Magazine* may be of interest to you for a "chuckle":

> F.G., PORTLAND, ORE. An easy method for hardening a piece of steel consists of immersing the metal in a tank of boiling linseed oil to which rosin has been added in the proportion of one-eighth of a pound to a gallon of the oil. When the steel has reached the same temperature as the oil, remove it, dust it over with powdered rosin, and then plunge it into cold kerosene.

G. A. SELLERS,
Acting Head,
Kansas State College,
Manhattan, Kan.

Of course, as applied to steel in general, this is a "chuckle," but there might be compositions in which using boiling oil for isothermal transformation, a sort of austempering, might give usable results.—THE EDITORS.

A Chuckle—or a Groan?

In the leading editorial in *Power Plant Engineering* for August we find, in a discussion dealing with corrosion, wear and fatigue of materials in power plant construction, that the words "fatigue" or "endurance" are not used. Instead, the old misphrasing "crystallization" is exclusively employed. This hardy perennial still lives and though we can be philosophical if we find it in *Collier's*, it does gripe us to meet it in a journal whose title includes the word "engineering," and used by the editor at that.—H. W. G.

The Beer Can vs. the Bottle

We don't know the most recent statistics of the scrap between the beer bottle and the beer can; moreover the past statistics seem to be too much beset with wishful thinking of the side reporting them, to be quantitatively acceptable.

Qualitative indication that the can may have the upper hand for the moment is found in *Time* for Oct. 9, which, reporting on the American Legion convention in Chicago, concludes its account, "the Legionnaires threw the last empty beer can in the gutter, put away their rattles, and went home."—H.W.G.

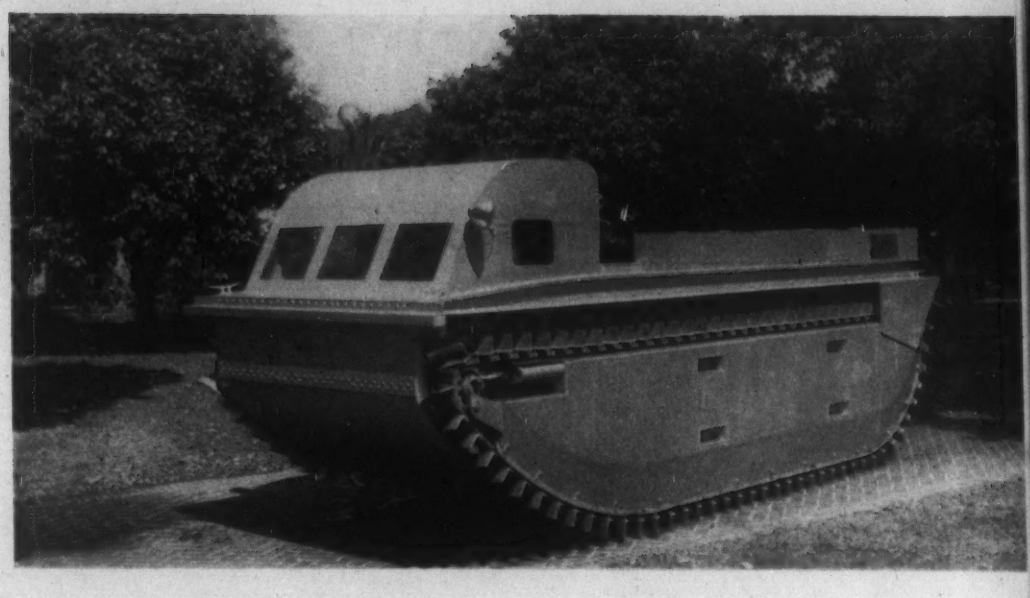
Light-Weight "Alligator" of Aluminum Alloy

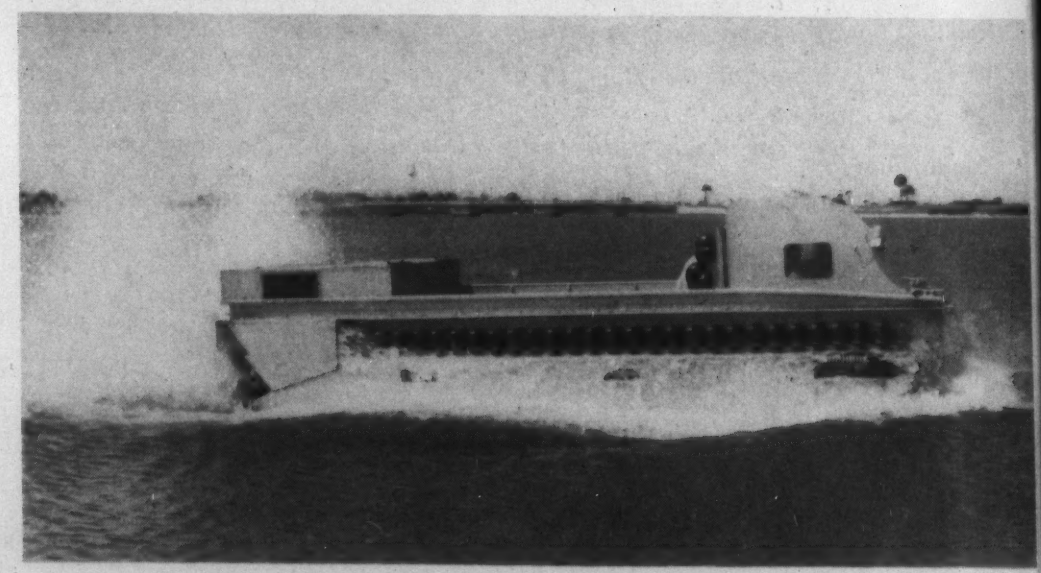
WHAT SEEMS TO BE a considerable improvement on the "marsh buggy," described in our February 1937 issue, is the new swamp or jungle amphibian conveyance recently designed and built by Donald Roebling of Clearwater, Fla. Constructed almost entirely of aluminum alloy for light-weight, the "Alligator," as its builder has christened it, can travel 15 to 25 miles per hr. on land through tangled growth, and up to 10 miles per hr. in the water. It is non-sinkable, even with its 7,000 lb. cargo compartment full of water, non-capsizable, and, tests show, can even take a 6-ft. dive into deep water without damage to itself or injury to its driver.

The hull, chiefly of riveted construction, is of Alcoa 17ST except for the bottom plate, which is Alcoa 24ST. The propulsion method (on both land and water) is through special Link-Belt roller chains with unusually high T-shaped curved aluminum alloy cleats bolted on. The cleats are of extruded Alcoa 24ST, and have a stem 6 in. high and a top that is 4 in. wide, forged to a 10½ in. radius. Observation of recent operations have shown so little wear of the aluminum treads that no limit to their life can be estimated. The total weight of the "Alligator" is 7700 lbs. without fuel or tools, which add another 800 lbs. The power plant is a Ford V-8 engine with Federal-Mogul high-compression copper cylinder heads, giving about 110 hp. at 3800 r.p.m., and power is delivered to the treads through a standard Ford clutch. All bearings are anti-friction. The gear cases are of cast aluminum for lightness.

Among the other structural features claimed to make the "Alligator" highly adaptable for swamp rescue work are its easy manipulation (it can be turned almost on a dime); its roomy passenger and cargo compartment, which will hold 40 people; and its cruising range, about 400 miles. In addition to this special service for which it was designed, the maker is now suggesting it for exploration and other service in heavy jungle sections. At present, the cost is high and there is as yet little prospect of anything like multiple construction.

Although the "Alligator," described and illustrated here according to data supplied by the builder, is made of aluminum alloy, Mr. Roebling is considering fabricating the next one of stainless steel.





Copper-Zirconium-Cadmium Bronze

by F. R. HENSEL, E. I. LARSEN, AND A. S. DOTY

Metallurgical Consultant, Division Engineer and Metallurgical Engineer, respectively, the P. R. Mallory & Co., Inc., Indianapolis, Ind.

This article presents the results of an extended investigation of alloys of copper, zirconium and cadmium. Its frankness and detail take one behind the scenes in a rather unusual fashion. The details give a lot of information.

The authors present a new high strength, high conductivity alloy or bronze which is claimed to be superior in hardness and strength to the copper-cadmium alloys or bronzes—without severe loss in electrical conductivity. Its present applications include electrical conducting members, welding electrodes and heat-conducting members.—The Editors.

THE SYSTEM COPPER-ZIRCONIUM was investigated by T. E. Allibone and Sykes[1]. It was found that the copper-rich alloys exhibited a variable solid solubility and the limit of solid solubility at room temperatures was placed at approximately 0.2 per cent. A eutectic was formed in the system at approximately 12.5 per cent zirconium. The eutectic temperature was given as 964 deg. C.

Sykes found that with increasing percentages of zirconium, the ultimate strength increased. He reports results as shown in Table I.

Further data on copper-zirconium were reported by J. D. Fast[2]. Data on copper alloys with beryllium and zirconium were reported by Comstock and Bannon[3].

Table I—Effect of Zirconium Content on Strength of Binary Cu-Zr Alloys

Zirconium, Per cent	Brinell Hardness		Ultimate Strength, Tons per sq. in., Normalized	Elongation
	As Cast	Normalized		
0	54	60	14	50.0
0.5	60	70	17.3	50.0
1	72	82	18.5	37.5
2	91	91	20.6	25.0
4	101	115	23.8	9.5
6	137	127	27.2	4.0
8	155	137	28.5	1.2

Study of the Binary System Cu-Zr

The authors re-investigated part of the binary system of Cu-Zr and found the location of the eutectic temperature at 966 deg. C. A microscopic analysis showed that even with only 0.3 per cent Zr, a free constituent appears.

The thermal and microscopic analysis indicated a change of solid solubility with temperature and age-hardening tests confirmed these assumptions. The results of tests made with copper-zirconium alloy (*See also curves in U. S. P. 2097816) containing by analysis 0.93 per cent Zr, are shown in Figs. 1, 2, 3, and 4. In Figs. 1 and 2 the effect of aging time is shown on hardness and electrical conductivity. The materials were quenched from 950 deg. C., which is below the eutectic temperature, and aged at 450 deg. C. The hardness increased from 10 Rockwell "B" after quenching to 59 Rockwell "B," after aging for 8 hrs. The electrical conductivity increased from 49 per cent after quenching, to 76 per cent after aging for 16 hrs. at 450 deg. C. The materials could be cold worked from 50 Rockwell "B" to 75 Rockwell "B," as seen in Fig. 4. This cold work hardness is retained up to fairly high temperatures, as is evident from Fig. 3, in which the hardness is plotted as a function of the annealing temperature.

In comparing the results of the binary copper-zirconium system, with other commercially available materials, it was concluded that the properties, and more particularly the hardness, did not reach values that made the material attractive enough as a substitute for present day alloys. Therefore, in order to obtain a new commercial alloy, of high electrical and tensile properties, the ternary system copper-cadmium-zirconium was investigated in the range

Table II—Effect of Annealing Temperature on the Physical Properties of an Alloy Containing 1% Cd and 99% Cu.

Treatment	Proportional Limit Lbs. per Sq. In.	Yield Point Lbs. per Sq. In.	Tensile Strength Lbs. per Sq. In.	Exten. % in 2 in.	Reduction of Area per cent	Modulus of Elasticity Lbs. per sq. in. × 10^6
Not treated	11,200	61,000	61,200	18.5	64	19.5
1 hr. at 200° C.	19,500	60,500	61,100	17.5	64	19.5
1 hr. at 250° C.	42,000	55,000	60,500	21.9	64	19.5
1 hr. at 300° C.	41,000	49,500	57,500	25.8	65	19.5
1 hr. at 350° C.	6,500	33,000	48,800	33.9	70	21.0
1 hr. at 400° C.	5,850	13,400	38,500	48.6	75	14.2

where such alloys can be hot and cold worked, and treated in such a manner as to develop the best combination of electrical conductivity and tensile properties. The theoretical chemical composition of the final alloy was established as 0.35 per cent Zr, 0.90 per cent Cd, balance Cu. (*U. S. P. 2086329).

The Binary Cu-Cd Alloys

The binary copper-cadmium alloys are known to lend themselves very readily to cold working and the hardness and tensile properties obtained by such cold deformation are retained fairly well up to 300 to 350 deg. C. A series of tests were run on a material containing 1 per cent Cd, balance Cu, and the physical properties determined as a function of the annealing temperature. In Table II the results of these tests are tabulated.

In addition to the above, the effect of annealing temperature on the hardness of a cold worked Cu-Cd alloy (1% Cd) was determined. Fig. 5 shows results of this investigation. From the curve it can be seen that the annealing temperature of this alloy is approximately 350 deg. C.

In the manufacture of high conductivity Cu-Cd alloys, tests have shown that certain impurities, and

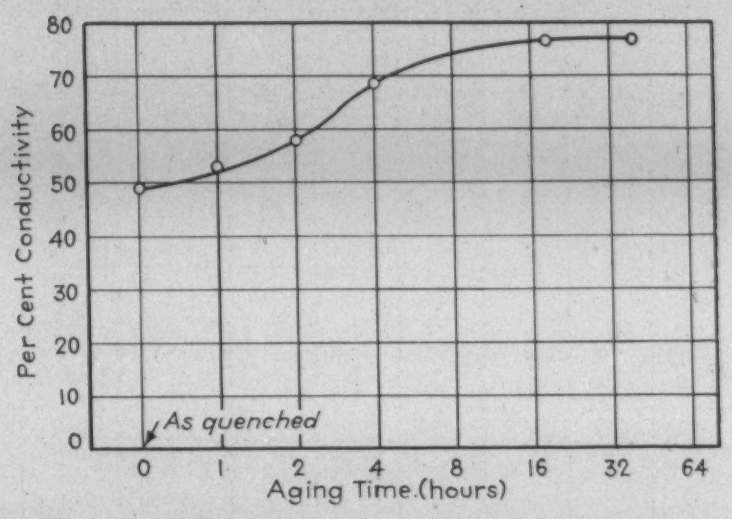


Fig. 2. Conductivity vs. aging time on copper-zirconium bronze (99% Cu-1% Zr). Quenched from 950 deg. C. Aged at 450 deg. C.

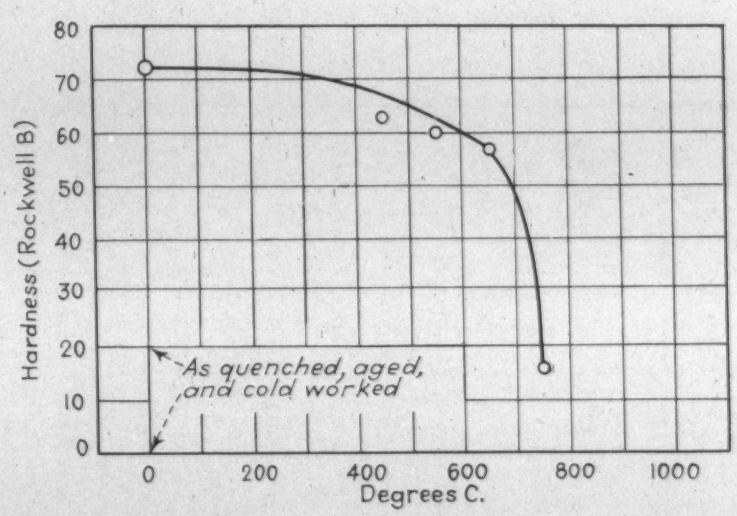
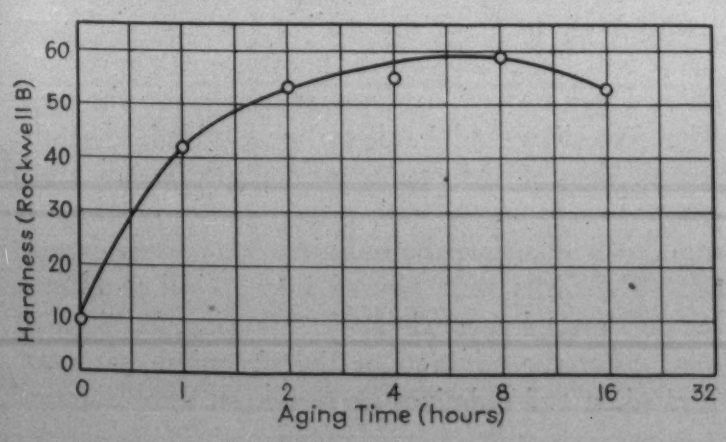


Fig. 3. Annealing curve on copper-zirconium bronze (99% Cu-1% Zr). (Specimen was quenched from 950 deg. C., aged 16 hrs. at 450 deg. C., cold worked 10%, and annealed 2 hrs. at each indicated temperature.)

Fig. 1. Hardness vs. aging time on copper-zirconium bronze, (99% Cu-1% Zr). Quenched from 950 deg. C. Aged at 450 deg. C.



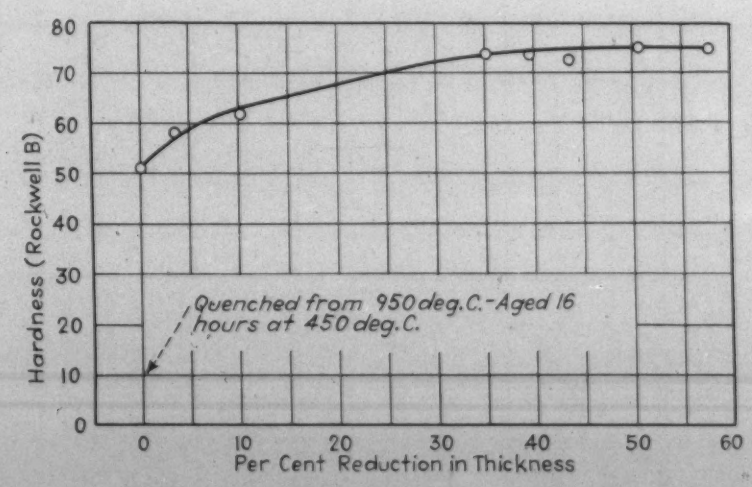


Fig. 4. Effect of cold working on the hardness of heat-treated copper-zirconium bronze, (99% Cu-1% Zr).

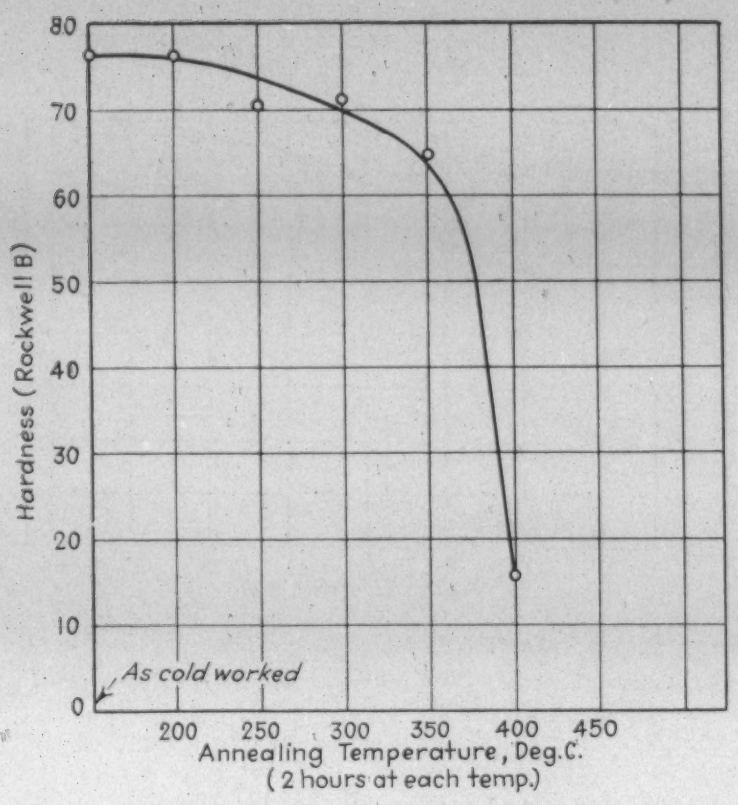


Fig. 5. Annealing curve on copper-cadmium bronze, (99% Cu-1% Cd).

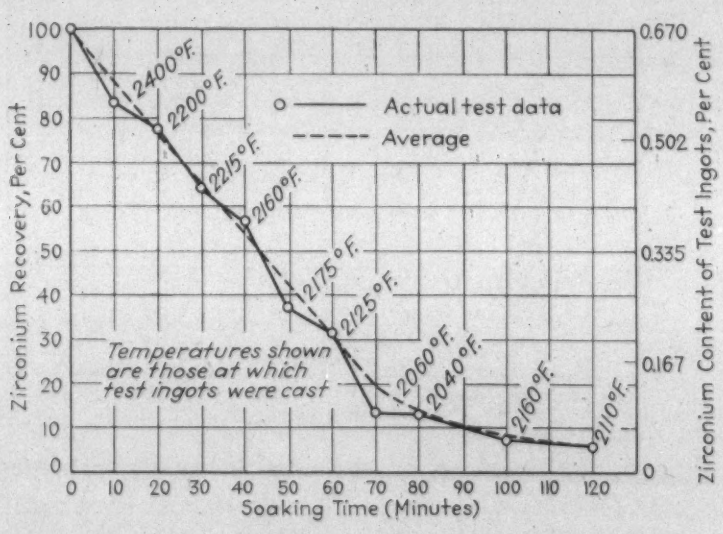


Fig. 6. Effect of soaking time on zirconium recovery in making copper-zirconium-cadmium bronze.

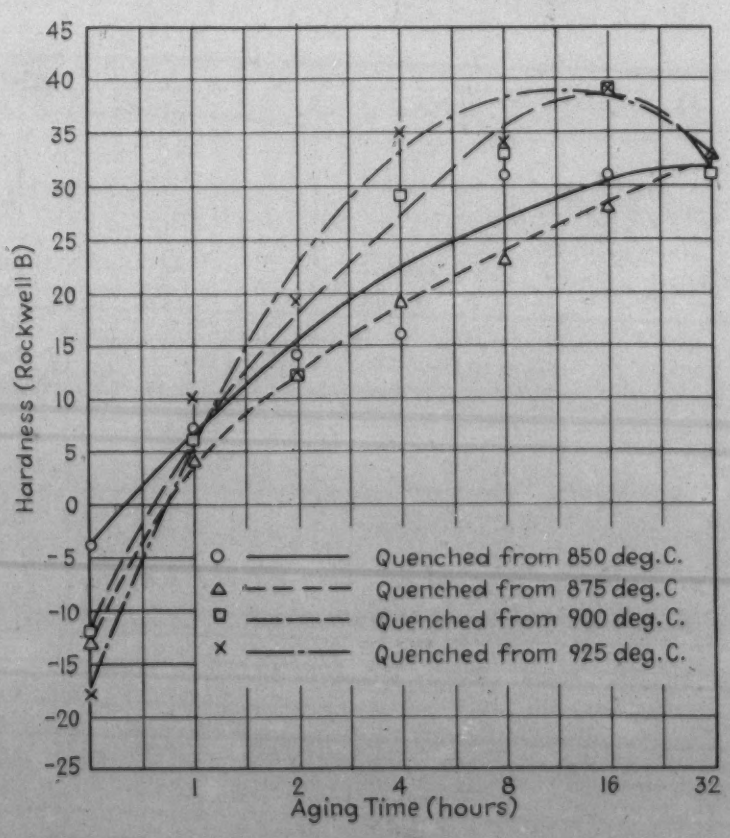


Fig. 7. Hardness vs. aging time after quenching from various temperatures. L845 (98.66% Cu, 0.45% Zr, 0.83% Cd, and 0.06% Mg).

particularly iron, will reduce the electrical conductivity. On the other hand, minute percentages of silicon are beneficial. U. S. P. 1908089.

Cu-Zr Concentrate

It was found that the addition of pure zirconium to copper melts was highly impractical from the standpoint of zirconium recovery and formation of zirconium oxide. Zirconium hydride was also used with very little improvement in recoveries and, in addition, the gas evolution prevented production of sound billets.

In order to find a suitable form in which zirconium may be added, a series of tests were conducted on the preparation of suitable Cu-Zr hardener. It was finally decided to use zirconium hydride as the basic material for the preparation of the Cu-Zr alloy. A special technique was developed to produce two grades of hardeners, one containing 12½ per cent Zr, balance Cu, and the other one containing 35 per cent Zr, balance Cu.

These hardeners are prepared by a powder metallurgical process. The sintering is carried out in a reducing atmosphere and the hydrogen liberated by the hydride is an additional protection to prevent oxidation. The process of making this hardener is designated by the trade name "Hydrimet." (Material produced under license arrangement with Metal Hydrides.) The hardener will be attacked slightly by moist air and must be suitably protected in storage.

Melting Procedures for Cu-Zr-Cd Bronze

Zirconium is a material which is highly oxidizable. It therefore acts as a very powerful deoxidizer in copper melts. Tests have shown that by adding 0.1 to 0.2 per cent Zr, copper castings can be produced which are entirely free from oxides or gases. A number of tests were made to determine the zirconium recovery in the Cu-Zr-Cd bronze. Zirconium was added as a 12-½ per cent eutectic Zr-Cu master alloy, and the cadmium was added in the form of compressed briquettes, containing 25 per cent Cd, balance Cu. The copper was melted under a charcoal cover and the melts were deoxidized with a small percentage of copper-phosphorus which was added immediately prior to the addition of the zirconium hardener. The amount of phosphorus was so calculated that no residual amount was left in the melt. The deoxidizer and hardener were added when the temperature of the copper was approximately 2300 deg. F. The melts were then soaked for about 5 min., at which time the cadmium hardener was added. The melts were poured into a chill mold at a temperature of approximately 2100 deg. F., 7 to 10 min., after the addition of the zirconium hardener. Zirconium and cadmium recoveries on three different

Table III—Zirconium & Cadmium Recoveries in Typical Melts of Cu-Cd-Zr Bronze

	Zirconium			Cadmium		
Sample	Added (%)	By Anal. (%)	Recovery (%)	Added (%)	By Anal. (%)	Recovery (%)
L-618	0.67	0.485	72.4	1.2	1.10	91.8
L-619	0.67	0.58	86.5	1.2	1.05	87.5
L-620	0.67	0.485	72.4	1.2	1.00	83.5

melts made in this manner are shown in Table III.

In addition to the above experiments, an investigation was carried out to determine the effect of "soaking time" on the zirconium recovery. The same melting procedure was followed, with the exception that test ingots were cast every 10 min. for 2 hrs., after the addition of the zirconium. Chemical analyses were made on each of the test ingots and the results are given in Fig. 6. From this curve it is quite apparent that the zirconium recovery decreases very rapidly with soaking time. In other words, it is highly advisable to pour the melt as soon as possible after the addition of zirconium in order to obtain good recovery.

Several large production heats were made of copper-zirconium-cadmium bronze. The materials were melted in a 60-cycle Ajax-Wyatt induction furnace. The charge consisted of the following materials:

a. Cathode copper
b. 25 per cent Cd-Cu fused ingot
c. 35 per cent Zr-Cu fused pigs
d. 30 per cent Si-Cu deoxidizers

A typical charge was the following:

	Lbs.
Furnace button	500
Cathode copper	1728
25 per cent Cu-Cd hardener	85
35 per cent Cu-Zr pigs	47

A bottle glass slag cover thinned with borax was used to cover the melt. In general, the procedure used was as follows:

1. Melt down all the copper
2. Deoxidize with Si-Cu
3. Add 25 per cent Cd-Cu pigs
4. Add the 35 per cent Zr-Cu which had been previously wrapped in copper foil.

The glass slag was pushed aside before each of the additions, and in the case of the 35 per cent Zr-Cu hardener, a stirring rod was used to get it under the surface of the bath. No trouble was encountered in the production of any of the melts. The ingots shrank well and showed no signs of swelling or blowing. The fused 25 per cent Cd-Cu hardener went into the melt without excessive boiling or fuming. No trouble was encountered in the addition of the 35 per cent Zr-Cu hardener. It dissolved quite readily. The log of a typical melt is given on the next page:

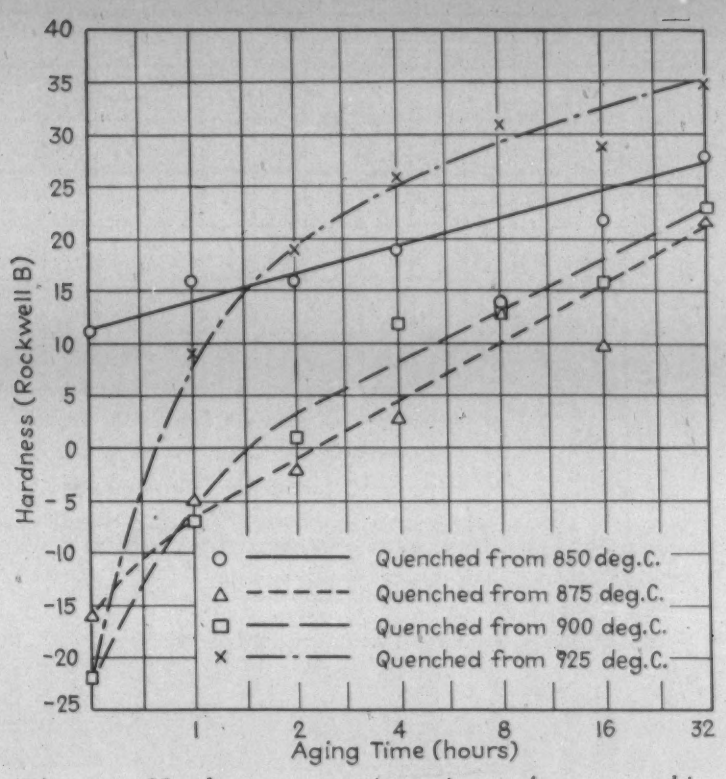


Fig. 8. Hardness vs. aging time after quenching from various temperatures. L854 (98.86% Cu, 0.22% Zr, 0.87% Cd, and 0.08% Si).

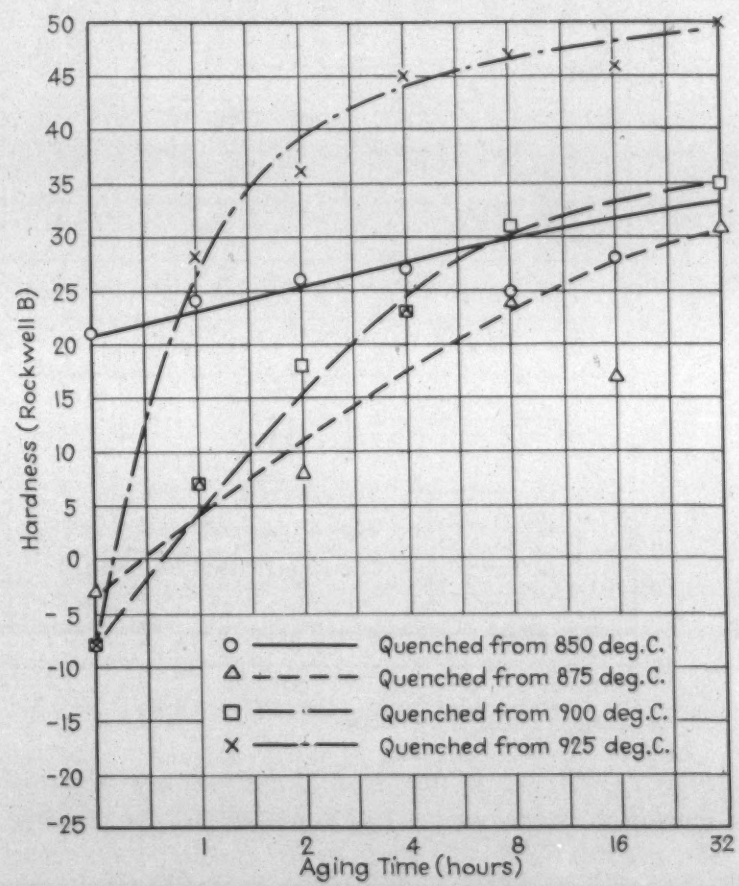


Fig. 9. Hardness vs. aging time after quenching from various temperatures. L855 (98.70% Cu, 0.40% Zr, 0.82% Cd, and 0.09% Si).

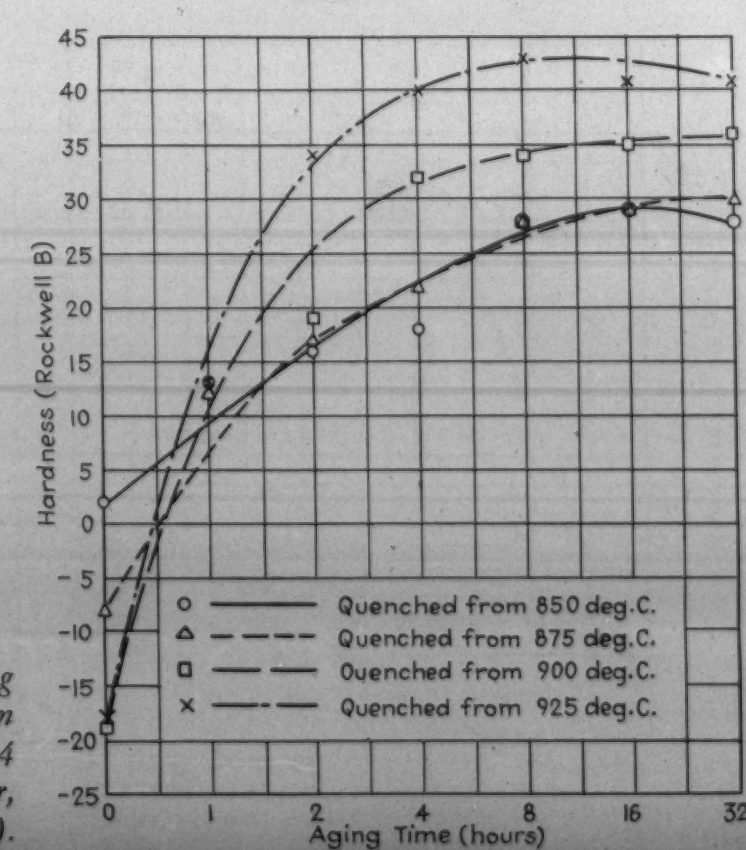


Fig. 10. Hardness vs. aging time after quenching from various temperatures. L864 (98.94% Cu, 0.32% Zr, 0.70% Cd, and 0.03% Li).

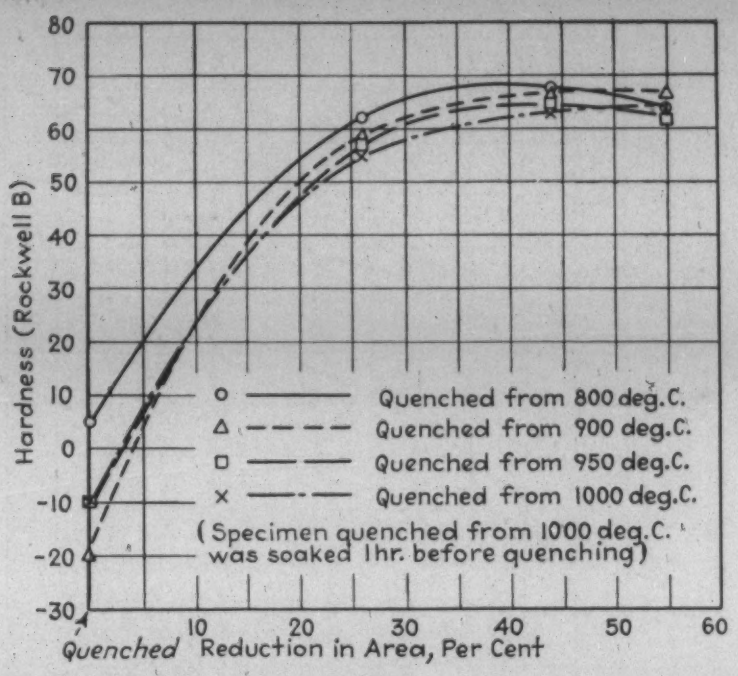


Fig. 11. Effect of quenching temperature on cold working after quenching. L812 (98.97% Cu, 0.28% Zr, 0.72% Cd). Rod, 1/2 in. diameter, quenched and swaged.

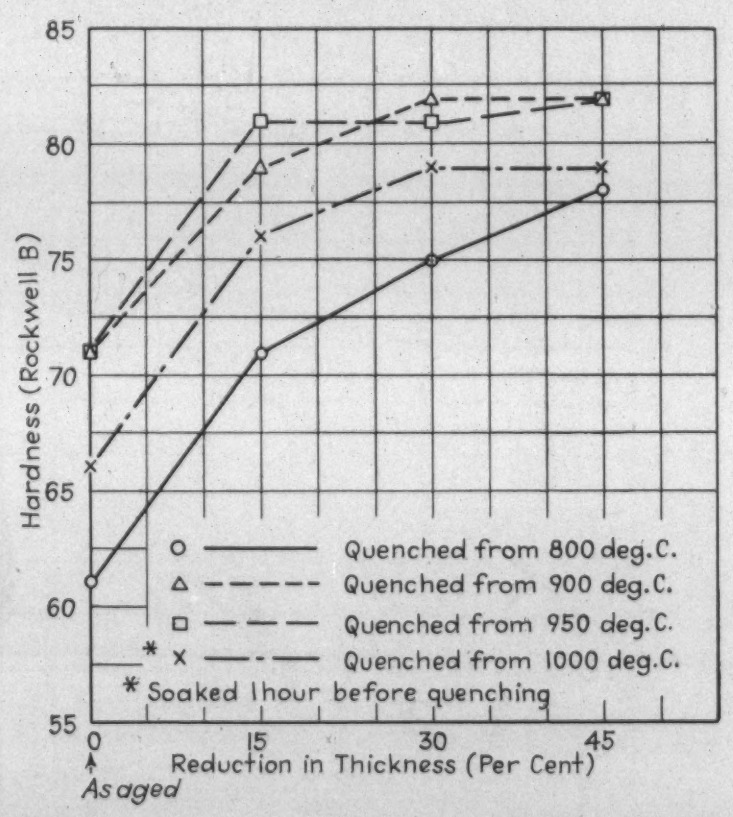


Fig. 12. Effect of quenching temperature on cold working after aging. L812 (98.97% Cu, 0.28% Zr, 0.72% Cd). (1) Rod, 1/2 in. diameter, quenched and swaged cold to 44% R.A. (2) Aged 8 hrs. at 400 deg. C. (3) Sections, 1/2 in. thick, cold hammered to 15%, 30%, 45% reduction in thickness.

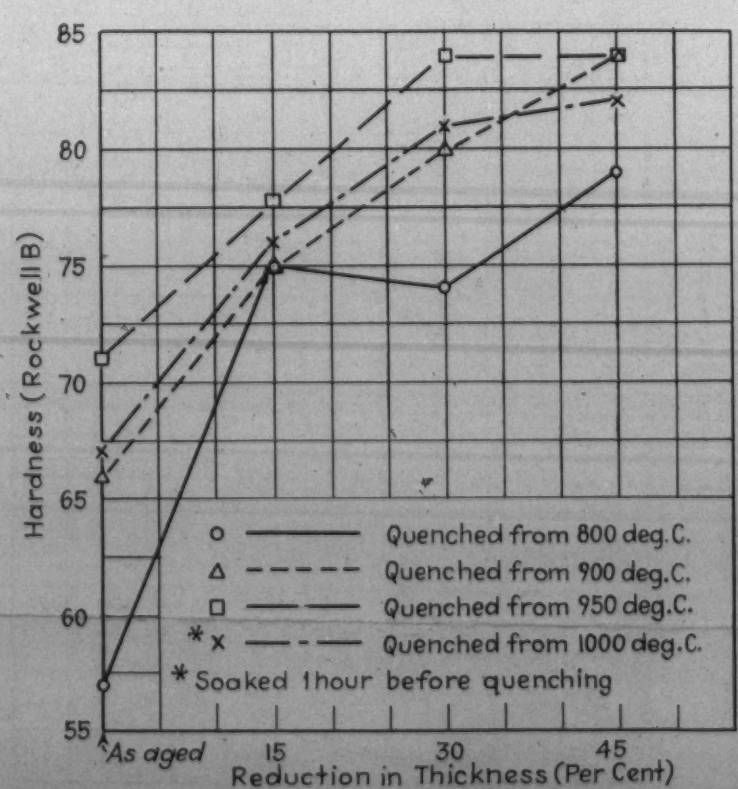


Fig. 13. Effect of quenching temperature on cold working after aging. L812 (98.97% Cu, 0.28 Zr, 0.72% Cd). (1) Rod, 1/2 in. diameter, quenched and swaged cold to 55% R.A. (2) Aged 8 hrs. at 400 deg. C. (3) Sections, 1/2 in. thick, cold hammered to 15%, 30%, 45% reduction in thickness.

Operation	Time
Copper all melted	12:11
Deoxidized with 5 lbs. of 30 per cent Si-Cu	12:11
25 per cent Cu-Cd hardener added	12:14
Temperature 2200 deg. F.	12:17
Started to add 35 per cent Zr-Cu	12:18
All 35 per cent Zr-Cu in melt	12:20
Temperature 2190 deg. F.	12:22
Pouring started	12:22
Pouring finished	12:30

Chips were obtained from the top and bottom of the ingots poured. The analysis of the bottom of the billet would correspond to the composition of the melt at the start of pouring, and the analysis of the top of the billet would correspond to the composition of the bath at the end of the pouring. Table IV lists the compositions of three typical billets.

Table IV—Chemical Analyses of Typical Production Heats of Cu-Zr-Cd Bronze.

	Melt No. 1		Melt No. 2		Melt No. 3	
Element	Bottom	Top	Bottom	Top	Bottom	Top
Copper	98.60	98.69	98.58	98.68	98.55	98.65
Cadmium	0.88	0.80	0.93	0.81	0.93	0.84
Zirconium	0.45	0.47	0.43	0.45	0.43	0.43
Silicon	0.04	0.05	0.04	0.05	0.06	0.04

The results in Table IV indicated the average zirconium recovery to be 63.2 per cent and the average cadmium recovery 95 per cent.

Effect of Deoxidizer on the Age Hardening Characteristics

A series of tests were conducted in which phosphorus, silicon, magnesium and lithium were used as deoxidizers.

1. It was definitely established that the presence of phosphorus seriously interferes with the age hardening of the alloy. An alloy was prepared having the following analysis:

Copper	98.70 per cent
Zirconium	0.47 per cent
Cadmium	0.72 per cent
Phosphorus	0.05 per cent

This alloy did not respond to heat treatment. In order to verify the result, two more billets of the same intended composition were made and found to confirm the previous results.

2. An alloy was made of the following composition:

Copper	98.66 per cent
Zirconium	0.43 per cent
Cadmium	0.83 per cent
Magnesium	0.06 per cent

The age hardening results of this alloy are shown in Fig. 7. The most pronounced hardening resulted by quenching from 900 deg. C. and aging for ap-

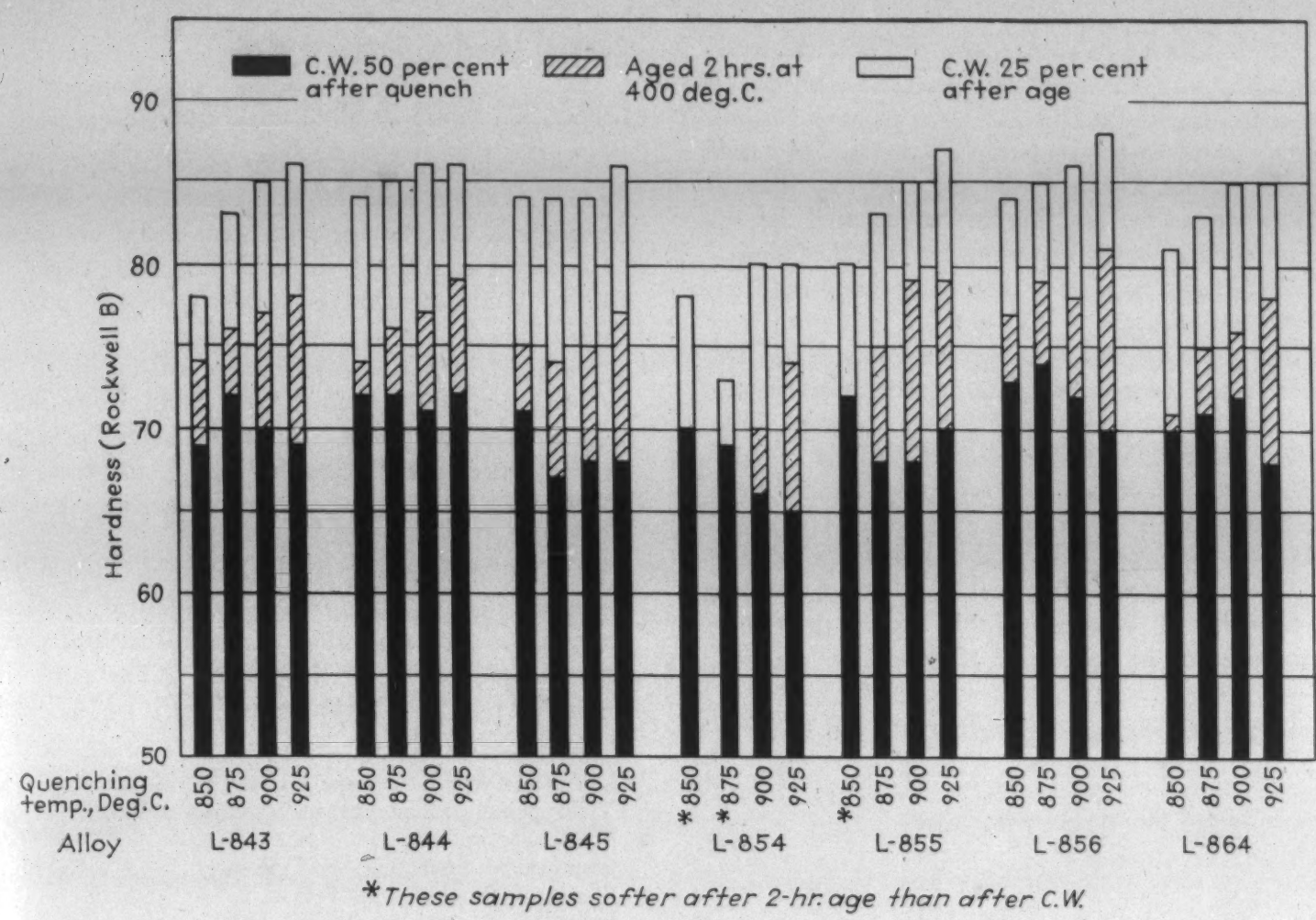


Fig. 14. Diagram showing hardness at various points in process of manufacture. L843, L844, L845, L854, L855, L856, L864. Samples were: (1) Quenched. (2) Cold pressed 50 per cent reduction in thickness. (3) Aged 2 hrs. at 400 deg. C. (4) Cold pressed 25 per cent reduction in thickness.

proximately 8 to 16 hrs. at 450 deg. C.

3. An alloy was made of the following composition:

Copper	98.86 per cent
Zirconium	0.22 per cent
Cadmium	0.87 per cent
Silicon	0.08 per cent

The age hardening curves of this alloy are shown in Fig. 8. In this case, the optimum quenching temperature was 925 deg. C., producing the most pronounced aging results at 450 deg. C.

4. Since the billet reported under "3" had a low zirconium content, a duplicate sample was made aiming at a higher zirconium percentage. This alloy had the following composition:

Copper	98.70 per cent
Zirconium	0.40 per cent
Cadmium	0.82 per cent
Silicon	0.09 per cent

The age-hardening results are shown in Fig. 9. It is quite evident that the average hardness values are considerably above those obtained in the billet mentioned under "3", containing only 0.22 per cent Zr.

5. A billet was made containing 98.94 Cu, 0.32 Zr, 0.70 Cd, and 0.03 per cent Li. The results of the heat-treating tests are shown in Fig. 10. The material ages properly. The best quenching temperature is 925 deg. C.

Effect of Combining Cold Working and Aging

A series of cold working tests were made on a material of the following composition (Alloy L-812):

Copper	98.97 per cent
Zirconium	0.28 per cent
Cadmium	0.72 per cent

A material of this type was quenched from various temperatures and then cold worked various percentages. The results of these experiments are contained in Fig. 11. From this curve it is evident that about 45 per cent cold work will give the maximum increase in hardness. It was, therefore, decided to use approximately 40 to 50 per cent cold work after quenching for processing commercial quantities of the Cu-Zr-Cd bronze.

In order to further increase the hardness, a cold working operation was used after the aging treatment. Tests were made on the same material as above, and the results are contained in Figs. 12 and

13. It is evident that 25 to 35 per cent reduction after aging will considerably raise the hardness. It was, therefore, decided to use in the commercial procedure a 25 to 35 per cent cold reduction. The actual hardness values shown in the previous two illustrations are somewhat low, due to the fact that the zirconium content is slightly below the specified limit.

It should also be noticed that aging was carried out in these experiments at 400 deg. C., rather than at 450 deg. C. The cold working after quenching rapidly increases the rate of aging and therefore it was found safe to reduce the aging temperature to 400 deg. C. In Table VI and Fig. 14 the results are given on hardness of a series of alloys which were quenched from 850, 875, 900, and 925 deg. C., cold worked 45 to 50 per cent aged 1 and 2 hrs., at 400 deg. C., and further cold worked to 25 to 50 per cent reduction in thickness. Table V gives the chemical composition of this series of alloys.

Table V—Chemical Composition of the Series

Alloy No.	Cu	Zr	Cd	Si	Li	Mg
843	98.68	0.41	0.88	...	...	...
844	98.52	0.48	0.98	...	...	...
845	98.66	0.43	0.83	...	...	0.06
854	98.86	0.22	0.87	0.08	...	...
855	98.70	0.40	0.82	0.09	...	...
856	98.53	0.59	0.81	0.04	...	...
864	98.94	0.34	0.70	...	0.03	...

From these data it is quite evident that, with the proper treatment, the new alloys can be produced with a minimum hardness of 80 Rockwell B and an average hardness of 83 to 85 Rockwell B, in sections up to 1 in. diameter.

Table VI—Hardness at Various Points in Process of Manufacture of Cu-Zr-Cd Bronze

		Hardness (Rockwell B)			
			As Aged		
Alloy	Quenching Temp. Deg. C.	As Cold Worked After Quenching	1 Hr.	2 Hrs.	As Cold Worked After Aging
L-843	850	69	75	74	78
	875	72	76	76	83
	900	70	77	77	85
	925	69	77	78	86
L-844	850	72	74	74	84
	875	72	77	76	85
	900	71	78	77	86
	925	72	81	79	86
L-845	850	71	75	75	84
	875	67	75	74	84
	900	68	77	75	84
	925	68	77	77	86
L-854	850	70	42	37	78
	875	69	70	66	73
	900	66	73	70	80
	925	65	74	74	80
L-855	850	72	74	69	80
	875	68	77	75	83
	900	68	78	79	85
	925	70	80	79	87
L-856	850	73	78	77	84
	875	74	79	79	85
	900	72	77	78	86
	925	70	80	81	88
L-864	850	70	75	71	81
	875	71	78	75	83
	900	72	77	76	85
	925	68	80	78	85

General Physical Properties of Production Heats in Cu-Zr-Cd Bronze

The production heats on this material were investigated as far as hardness and conductivity are concerned, and also tensile tests were made on round rods drawn to various dimensions. The values in Table VII are average values taken from inspection reports.

The material can also be forged satisfactorily. It was found that extruded billets would forge more readily than cast billets. A large number of seam welding wheels were made by forging, and the average hardness results obtained on such discs are shown in Table VIII.

It is quite evident that without any difficulties, hardness values of 78 to 83 can be obtained. A stress strain curve was prepared on a sample that was taken from a 5/8-in. diameter drawn rod. The curve is shown in Fig. 15. The properties which we obtained were the following:

Ultimate strength, Lbs. per sq. in.	78,000
Yield point (0.2 per cent in permanent set) Lbs. per sq. in.	73,000
Proportional limit, Lbs. per sq. in.	37,500
Elongation in 2 in., per cent	11
Reduction in area, per cent	40
Hardness (Rockwell B)	84-86
Electrical conductivity I. A. C. S., per cent	78

The softening characteristics of the alloy were determined by annealing the material 2 hrs., at various temperatures. The results of this test were shown in Fig. 16. As can be seen, the drop in hardness does not start until about 450 deg. C. The softening, of course, will be a function of the amount of cold working that has been applied to the material and with a very high amount of cold working, the ma-

Table VII—Average Hardness Values of Various Diameter Rods of Cu-Zr-Cd Bronze

Diameter, Ins.	Rockwell B Hardness	Conductivity, Per cent
7/16	81—87	78—81
1/2	81—85	80—82
5/8	80—84	77—81
3/4	82—85	76.5—78
7/8	85—86	75—77
1	87—88	77—78
1 1/8	81—83	83—86
1 1/4	81—82	85—87
1 1/2	80	78.3

Table VIII—Average Hardness Values on Various Sizes of Forged Rings and Discs of Cu-Zr-Cd Bronze

Size of Discs or Rings, In.	Hardness (Rockwell B)
10 dia. x 3/4 thick	78—81
10 1/2 dia. x 1/2 thick	80—82
10 O. D. x 3 I. D. x 3/4 thick	78—81
8 1/2 dia. x 1/2 thick	82—85
11 dia. x 1 1/16 thick	79—81
12 dia. x 3/8 thick	79—83

terial will over-age rather quickly and softening might occur at temperatures as low as 400 deg. C.

Hardness tests were also conducted at temperature. The following values were obtained for the Cu-Zr-Cd bronze:

Temperature	Hardness, Brinell
Room Temperature, Deg. C.	148
125	140
175	132
230	123
300	120
350	119

Hardness readings at elevated temperatures were taken, using an apparatus somewhat as follows:

The specimen to be tested in the form of a small rectangle, approximately ½ in. sq. and ¼ in. thick, was placed on a platen inside a small furnace in which the temperature could be accurately controlled. The standard 10 m. m. Brinell ball and mounting fixture were also enclosed in the furnace. The assembly was heated to the predetermined temperature and allowed to soak a sufficiently long time to insure uniform temperature distribution within the specimen. The load was then applied and held for 30 sec. at temperature. The specimen was then removed and the impression measured with the usual Brinell microscope.

Effect of Quenching Temperature on the Microstructure

It was found that materials that had been quenched from too high a temperature after hot forging, would crack on subsequent cold working. A microscopical investigation was made which showed the following results:

1. After quenching from 800 deg. C., some grain growth takes place. The resulting material had an average of 5000 to 7500 grains per square m. m.
2. After quenching from 900 deg. C., considerable grain growth occurred, the number of grains being 50 to 100 per square m. m.
3. After quenching from 950 deg. C., the grain size was similar to that of the previous experiment, but a segregation in the grain boundaries was noticeable.
4. After quenching from 1000 deg. C., the segregation in the grain boundaries was very pronounced, the grain size still remaining the same as after quenching from 900 deg. C.
5. After holding for 1 hr. at 900 deg. C., and quenching, the grain boundary segregation was similar to that found in the pieces quenched from 950 deg. C.
6. After holding for 1 hr. at 1000 deg. C., and quenching, the segregation in the grain boundaries was extremely bad, the grain size being approximately 50 grains per square m.m. This investigation indicated that the quenching temperature should not exceed 950 deg. C., and should preferably be 900 deg. C., and that the material should not be held for too long a period of time at such a high temperature.

Effect of Zirconium on Other Than Cadmium Bronzes

In connection with the investigation of Cu-Zr-Cd alloys, also a number of other systems were studied, such as the Cu-Zr-Sn alloys. It was found that in this system, zirconium also causes age hardening. The actual curves obtained in this system are contained in U. S. Patent 2,136,918.

Another system that was studied and found to give excellent properties, was the Cu-Zr-Fe alloys. Materials of this type could be age hardened without cold working, to a Rockwell B hardness of 62 to 65 and an electrical conductivity of 55 to 60 per cent. Further cold working raised the Rockwell B hardness

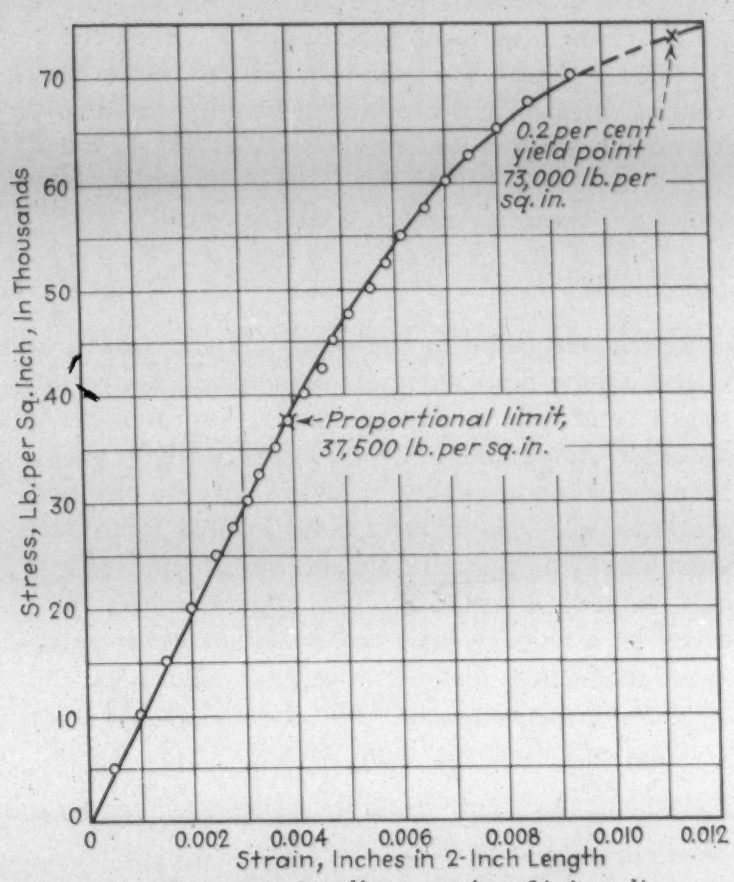


Fig. 15. Stress-strain diagram for ⅝-in. diameter drawn rod of copper-zirconium-cadmium bronze.

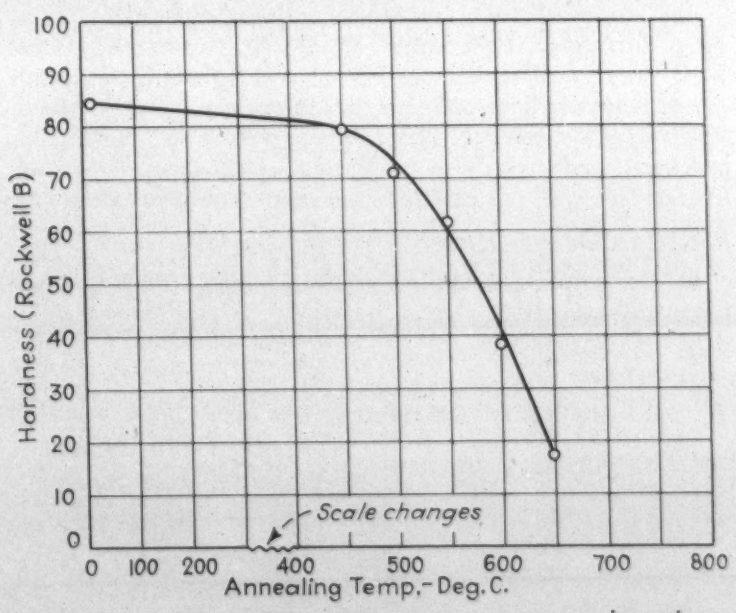


Fig. 16. Annealing curve on copper-zirconium-cadmium bronze.

to 85. The alloys are described in U. S. Patent 2,137,881. It was also found that the addition of zirconium greatly improves the alloys hardened with chromium silicides and nickel silicides (U. S. Patent 2,136,211 and 2,137,282). This investigation, however, will form the subject of another paper.

Conclusions

The investigation of the Cu-Zr-Cd alloys has produced a new high strength, high conductivity alloy which constitutes a very substantial improvement in hardness and strength over present straight Cu-Cd bronzes, without causing a severe loss in electrical conductivity. The alloys can be manufactured very satisfactorily on a large scale and can be handled in a mill without difficulties. The alloy has been produced on a tonnage basis and is being used for electrical conducting members, welding electrodes and heat-conducting members. The material should form an excellent alloy for high strength, high conductivity wire, such as is used for overhead wire and trolley wire.

Acknowledgment

The authors wish to acknowledge the very helpful assistance of Harry Croft, chief metallurgist of the Cleveland Works of the Chase Brass & Copper Co., where the new metal has been produced for the P. R. Mallory & Co., Inc. The authors, also, wish to thank the management of the P. R. Mallory & Co., Inc., for permission to publish these data. Acknowledgment is also given the valuable assistance of Dr. P. P. Alexander, general manager of Metal Hydrides, Inc.

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A Study in Export Data of Stainless and Alloy Steels

An analytical study of official export and import data often brings to light some interesting trends and facts. It is only since the beginning of 1937 that Government export statistics have revealed the export movement in stainless and alloy steels. The following study of these data has been made which is interesting as showing a decided foreign demand for certain American alloy products.

Rolled Stainless Steels

In the stainless steels, of particular interest are the exports of bars, plates, sheets and strip. The following table shows the export data for 1937, 1938 and to Oct. 1, 1939, in gross tons:

EXPORTS OF STAINLESS STEELS

	Bars	Plates	Sheets	Strip	Totals
1939 (9 mos.)	235	93	665	722	1715
1938	669	277	1681	632	3259
1937	223	148	1440	644	2455
1936	....	....	....	....	....
Totals	1127	518	3786	1998	7429

Thus in the 2 yrs. and 9 mos. foreign consumers have taken over 7400 gross tons of stainless bars, plates, sheets and strip in which sheets have predominated. The monthly outgo has varied from about 270 tons per month in 1937 to 198 tons monthly in 1939.

Rolled Alloy Steels

More impressive has been the movement abroad of American rolled alloy steel products, exclusive of stainless steel. The following table gives these data in gross tons:

EXPORTS OF ROLLED ALLOY STEEL (EXCLUSIVE OF STAINLESS)

	Bars	Plates	Sheets	Strip	Totals
1939 (9 mos.)	9142	1866	2593	401	14002
1938	7932	3034	3364	450	14780
1937	6398	5054	4730	1140	17322
1936	....	....	....	....	.....
Totals	23472	9454	10687	1991	46104

Thus in the 2 yrs. and 9 mos. since 1936 about 44,700 gross tons of rolled alloy steels (exclusive of stainless) have been sent abroad—a fairly sizable tonnage.

Ingots, Castings and Forgings

Besides these rolled alloy products—stainless and alloy—there has been an appreciable demand for alloy and stainless ingots, billets and blooms, and also castings and forgings. In this case the Government data do not separate the alloy and the stainless. The data for these are as follows in gross tons:

EXPORTS OF ALLOY AND STAINLESS INGOTS, CASTINGS AND FORGINGS IN GROSS TONS

	Ingots, etc.	Castings	Forgings
1939 (9 mos.)	14762	1114	1432
1938	7736	1146	993
1937	7232	1647	933
1936	....	....	....
Totals	29730	3907	3358

Thus in the 33 months' data under review the exports of ingots, billets and blooms, castings, and forgings have totaled over 28,800 tons with ingots, etc. comprising over 75 per cent of the total.

Summary

Recapitulating—the total exports of these stainless and alloy products have been as follows for the 33 months in gross tons:

Bars	24599
Plates	10472
Sheets	14473
Strip	3989
Ingots, etc.	29730
Castings	3907
Forgings	3358
Total	90528

This export movement from Jan. 1, 1937, to Oct. 1, 1939, or 33 months, has reached a total of over 80,750 gross tons. Of this, rolled alloy and stainless steel has comprised over 64 per cent with ingots, etc., about 27 per cent. This is a really commendable showing. With no data for 1936 or earlier, further comparisons are not possible. It is safe, however, to assume that the movement has reached its largest proportions in the last 2 or 3 yrs. The European war will interrupt this trend but when normal export shipments are resumed, it is probable that foreign demand for these stainless and alloy rolled, cast and forged products will further expand.—E.F.C.

Fatigue Problems in Structural Designs

PART 2 • CONCLUDED FROM NOVEMBER

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IV. FATIGUE DIAGRAMS OF STRUCTURAL ALLOYS

THE preparation of complete stress-resisting capacity diagrams requires a considerable number of long drawn tests, and in many cases complete diagrams are not available. Nevertheless, it would seem that the designer, before accepting an alloy, should request the furnishing of as complete diagrams as possible.

The tests which are necessary to obtain data for such diagrams are standard fatigue tests that can be conducted in nearly every fatigue testing laboratory.

The number of load applications to be considered depends entirely on the rapidity of probable stress variations and on the proposed life span of the structure. It may be entirely reasonable not to go to an unlimited number of load applications for many structures.

For structural elements the time-stress regime of which is similar to that given in Fig. 2, it may be possible to consider the pulsating strength only. For time-stress regimes similar to the ones shown in Fig. 3, the whole diagram including the pulsating and fatigue strength must be considered.

Fig. 7 shows, for instance, a complete bending, tension shear fatigue diagram (unlimited number of load applications) for polished specimens of silicon steel. The characteristics of this alloy are: C 0.25, Si 0.20 and Mn 0.60 per cent with ultimate strength in tension, 64,000 lbs. per sq. in. and elongation 20 per cent in 4 in.

The reduction of fatigue strength due to surface conditions may be established for steel alloys with relation to the ultimate strength as shown in Fig. 8. This reduction diagram is only approximate and variations are possible for different kinds of steel. Nevertheless it shows clearly the increased sensitivity of higher strength alloys.

In application of such diagrams to practical design problems, the region of permissible stress variations should be established as shown in Fig. 9. Using the fatigue diagram determined from tests made on polished specimens, reductions must be applied:

1. Due to the increased stress-resisting capacity of small sized specimens as compared with the larger sized structural elements.
2. Due to the surface conditions of the structural element which as a general rule will not be polished.
3. Safety factor reduction.

The remaining part of the diagram will then represent the safe region within which variable stresses can be applied without danger.

Such a diagram can be applied directly only to parts of structural elements that are continuous and at such points where no stress concentrations are possible.

The furnishing of such diagram may be considered as the final step defining the border line between the material testing and the structural laboratories. The structural engineer can hardly take a part in the investigation of alloys and in the long drawn tests that are necessary to produce such diagrams. A proper appraisal of structural alloys however is possible only if complete fatigue tests diagrams are available. In developing, for instance, high strength steel alloys, the structural designer is vitally interested in obtaining alloys that are structurally properly balanced. It is of little value to obtain an alloy of high ultimate strength without a corresponding increase of the yield point and the fatigue strength, or with an ex-

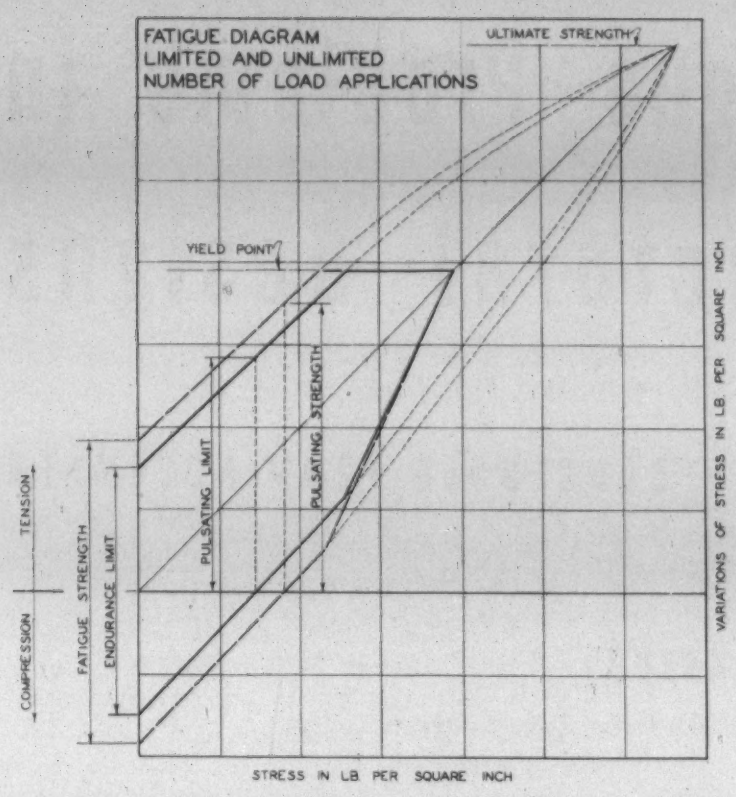


Fig. 6. Fatigue diagram—limited and unlimited number of load applications.

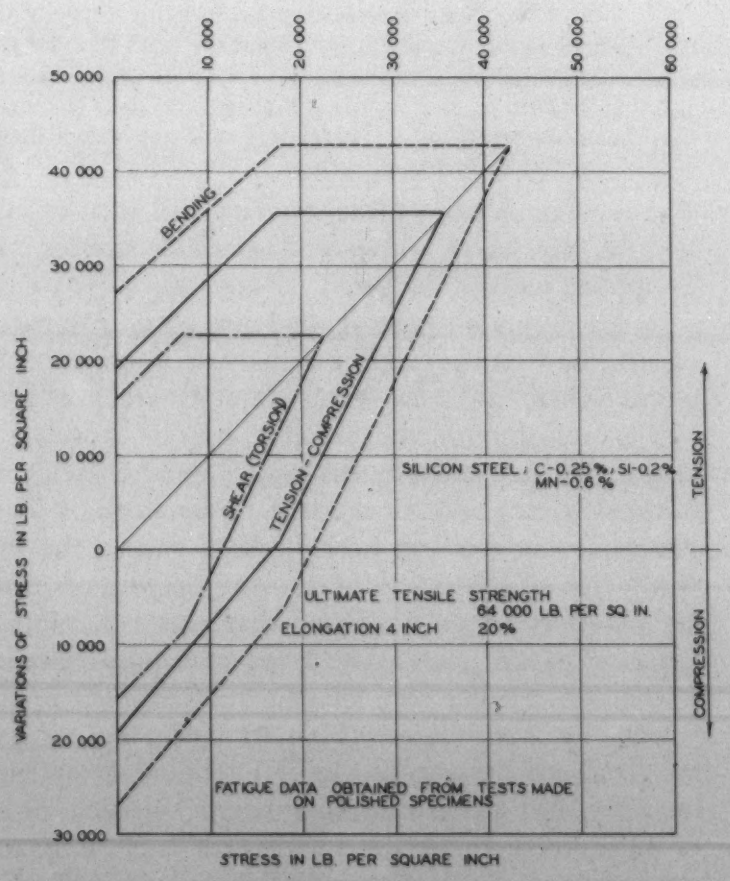


Fig. 7. Fatigue diagram—bending, tension, shear.

cessive lowering of elongation and ductility.

On the other hand the stress concentrations depend only to a small extent on the structure of the alloy, being predominantly and distinctly design problems. Since the stress concentrations have such an important bearing on the fatigue properties, the structural designer must continue the work of the material tester and by theoretical investigations and structural laboratory tests determine the fatigue properties of structural elements fabricated from alloys the fatigue properties of which are determined by the material tester.

V. FATIGUE PROPERTIES OF STRUCTURAL ELEMENTS

In determination of fatigue properties of materials, specimens can be used in which no appreciable stress concentrations occur or tests can be so run that the influence of stress concentrations is definitely limited to more or less known conditions. In engineering designs such means cannot be satisfactorily employed.

The major problem in applying the fatigue data to actual designs would be therefore the determination of the actual stress at the danger points. This problem in some instances may be rather complicated even in a continuous structural element, and it becomes still more complicated if consideration is given to the joints and points at which the forces are applied.

Stress Concentrations

In dealing with stresses that are developed by static loads it is customary to consider primarily, and very often exclusively, the stress in one plane or one cross-section only, disregarding the fact that there must be a difference in conditions at the boundaries as compared with the conditions within the structural member.

After forces are applied to a structural member stresses are developed at each point of it and as a general rule in three directions. The visualization of the stress conditions may be obtained by the use of stress fields or stress lines analogous to the fields and lines used in the study of electrical phenomena. If such analogy is accepted, the expression of the flow of stress may be employed.

If stress in one direction only is considered, then it can be represented by a single stress field; if stress in two or three directions is considered, then two or three stress fields must be drawn. The general representation of a three-dimensional stress field may be obtained by drawing of the three stress fields of the principal stresses.

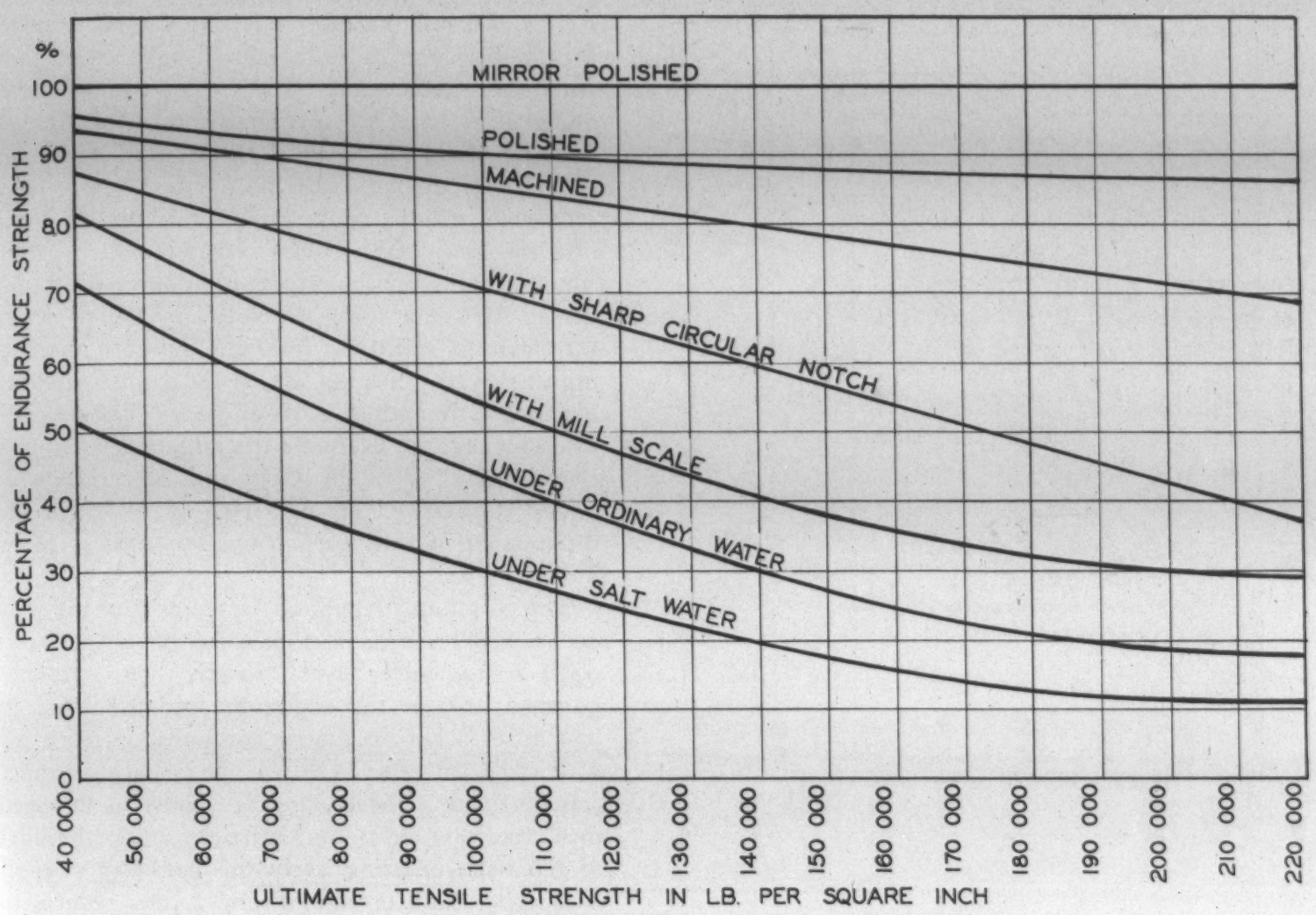


Fig. 8. Fatigue strength reduction due to surface conditions.

Flow of Stress

The purpose of every engineering structure is to receive external and gravitational forces and to distribute, transform and transmit them to some outside medium. Such action requires a continuous flow of stress within the structural elements and the transmitting of forces from one element to the other.

The flow of stress in many respects is very analogous to the flow of liquid. As long as no changes in conditions occur, the flow is more or less uniform and no stress concentrations occur. Any change in conditions disturbing the uniform and smooth flow results in stress concentrations which will tend gradually to smooth out if at a sufficient distance from the disturbance the uniform flow conditions are again re-established. More abrupt changes in the flow conditions are responsible for higher stress concentrations and, vice versa, a gradual and smooth change in flow conditions will result in moderate stress concentrations. The boundary will influence the stress conditions in the same way as the friction at the boundaries will influence the conditions of the boundary layer of a flowing liquid. A uniformity of the stress flow may be preserved in a uniform structural member, but at places where external forces are applied, or where changes in cross-section take place, or where the member joins other members, a flow disturbance must result. Even continuous welding will cause disturbances of the stress flow due to the unavoidable differences in the physical properties of the base metal and the welded joint.

The theoretically perfect method of determining fatigue properties of structural elements would be to determine the values of stress concentrations and to correlate these values with the data obtained from fatigue tests of materials. Such procedure however is very difficult due to limited knowledge of stress concentration factors, absence of satisfactory methods of theoretical determinations of such factors, uncertainty of exact measurements of stress in the small areas at which local stress concentrations occur.

In the present state of engineering knowledge, a reliable answer can only be obtained by the running

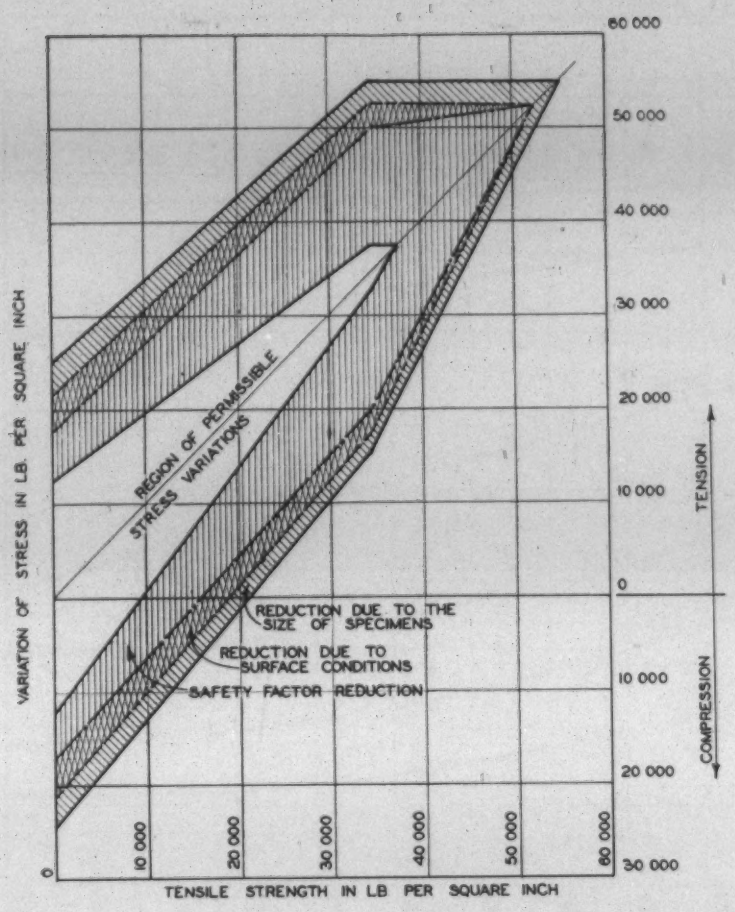


Fig. 9. Fatigue diagram—region of permissible stress variations.

of tests of actual structural members or models of them. This kind of testing cannot be conducted in an ordinary material testing laboratory but must be made in specially equipped laboratories. Since such tests are based on the use of materials the behavior of which has already been determined in ordinary material testing laboratories, the main attention is given to the design of the structural members. The whole problem becomes distinctly an engineering problem that must be solved by the engineer rather than by the metallurgist or material testing expert.

Extended scientifically conducted fatigue tests of this kind were first made in Germany. At present they are conducted in a number of laboratories. Prof. Wilbur M. Wilson is conducting a series of such tests at the University of Illinois at Urbana and Dean S. K. Hollister at Cornell University. Recently considerable progress has been made in the use of vibrators in fatigue testing of actual structures. The results of these tests in many cases can be used reversely to determine the actual stress concentrations at different points of simple structural members.

Riveted Joints

The joints relatively are the most expensive parts of a structure but the action of joints, the distribution of stress, the stress concentrations, etc., are not well known.

If a material possesses a certain fatigue strength, this strength can be fully utilized only if the joints permit such utilization. The fatigue strength determined on material test specimens does not disclose the behavior of the joint even if all elements of the joint are made of the same material. If, as in many cases, a different material is used for the rivets, the conditions become even more complicated. Fatigue strength, stress concentrations, tightness of the joint due to the compression developed by the rivets and the extent to which the rivet fills the hole, the bearing carried by the rivets, all are factors that influence the fatigue strength of a riveted joint. The results of extended tests to determine the pulsating strength of riveted joints made by Graf and Schaechterle are briefly summarized on Fig. 10. In all these tests the number of load applications was limited to two million.

The pulsating strength of the material of the joints determined on specimens polished on all sides was equal to the yield point strength. For specimens polished only at the edges, the pulsating strength was lower. For specimens not polished, with mill scale on, a still lower value of the pulsating strength was obtained. The drilling of a hole in the specimen results in stress concentrations along the edges of the hole, reducing again the pulsating strength. The tight filling of the hole by a rivet reduces the stress concentration and increases the pulsating strength.

The pulsating strength of a specimen with a hole and with two plates riveted to the specimen at both sides represents the maximum pulsating strength which a riveted connection may attain. The pulsating strength of actual riveted joints must be somewhat lower, and depends to a large extent on the friction between the splice plates and the joining plates, which in turn depends on the compression force developed by the rivets. The self-adjusting property of riveted connections is an important advantage which makes the fatigue strength of riveted joints practically independent of the way in which the rivets are distributed. The multiple row riveted joints are as effective as single row joints, provided the same ratio prevails between the tension stress, bearing, and frictional resistance of the different joints.

The best possible utilization of material in a riveted joint may therefore be obtained in a butt joint with splice plates using rivets of such material as will produce the highest compression, and spacing these rivets so as to obtain the tightest possible joint. Any greasing of the contact surfaces, as for instance by painting, will reduce the fatigue strength of a splice joint.

Welded Joints

The connections that were most commonly used in structural designs of the past were riveted or

bolted connections, to which at present must be added the welded connections. Welding is rapidly growing in importance in structural designs. The problem of weldability of alloys belongs to the field of the metallurgist; but the manner in which welds are made is a structural engineering problem.

Welded joints do not possess the self-adjusting properties of riveted joints and therefore the fatigue strength of welded joints may vary in exceedingly wide limits, depending on the design of the joints.

The flow of stress and stress concentrations that are responsible for such conditions are illustrated in Fig. 11. In a splice plates butt joint with frontal seams, the flow of stress is changed abruptly when the stress flow is crowded through the seams in order to reach the splice plates. A considerable stress peak must result. By increasing the thickness of the splice plates the stress in the plates may be reduced without however reducing the stress peak at the places where the welding seam connects the jointing members.

In a butt seam joint, only a slight disturbance of the stress flow occurs, resulting in a moderate stress concentration. The different welded connections can be placed between these two limiting cases.

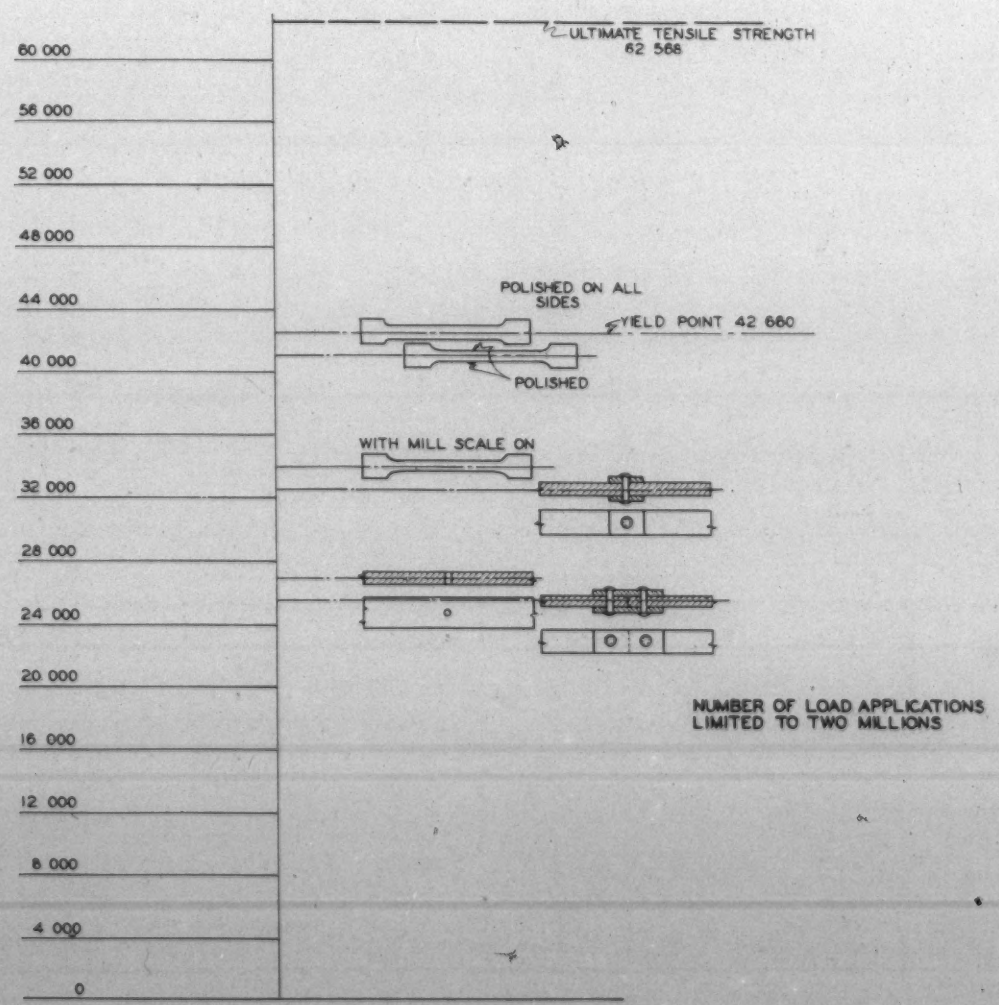
The results of the pulsating strength investigation of welded joints are briefly summarized in Fig. 12. This diagram is combined with the corresponding part of the fatigue diagram of the base material of the joints.

In order to clarify the problem of stress concentrations in different kinds of welded joints, model specimens 1 to 4 were tested. These models are made of solid material. The cross-seam welded to one side of model 2, reduces the pulsating strength of the original specimen 1, due to stress concentrations at the seam, also a certain weakening of the original bar due to the penetration zone of the weld. A seam on both sides, as shown on model 4, reduces the pulsating strength very considerably.

Model 3 represents the conditions of a splice joint, showing the considerable reduction in pulsating strength of such joints due to high stress concentrations.

The highest pulsating strength is attained in the joint 5; it is somewhat higher than 2, the stress

Fig. 10. Pulsating strength of riveted joints.



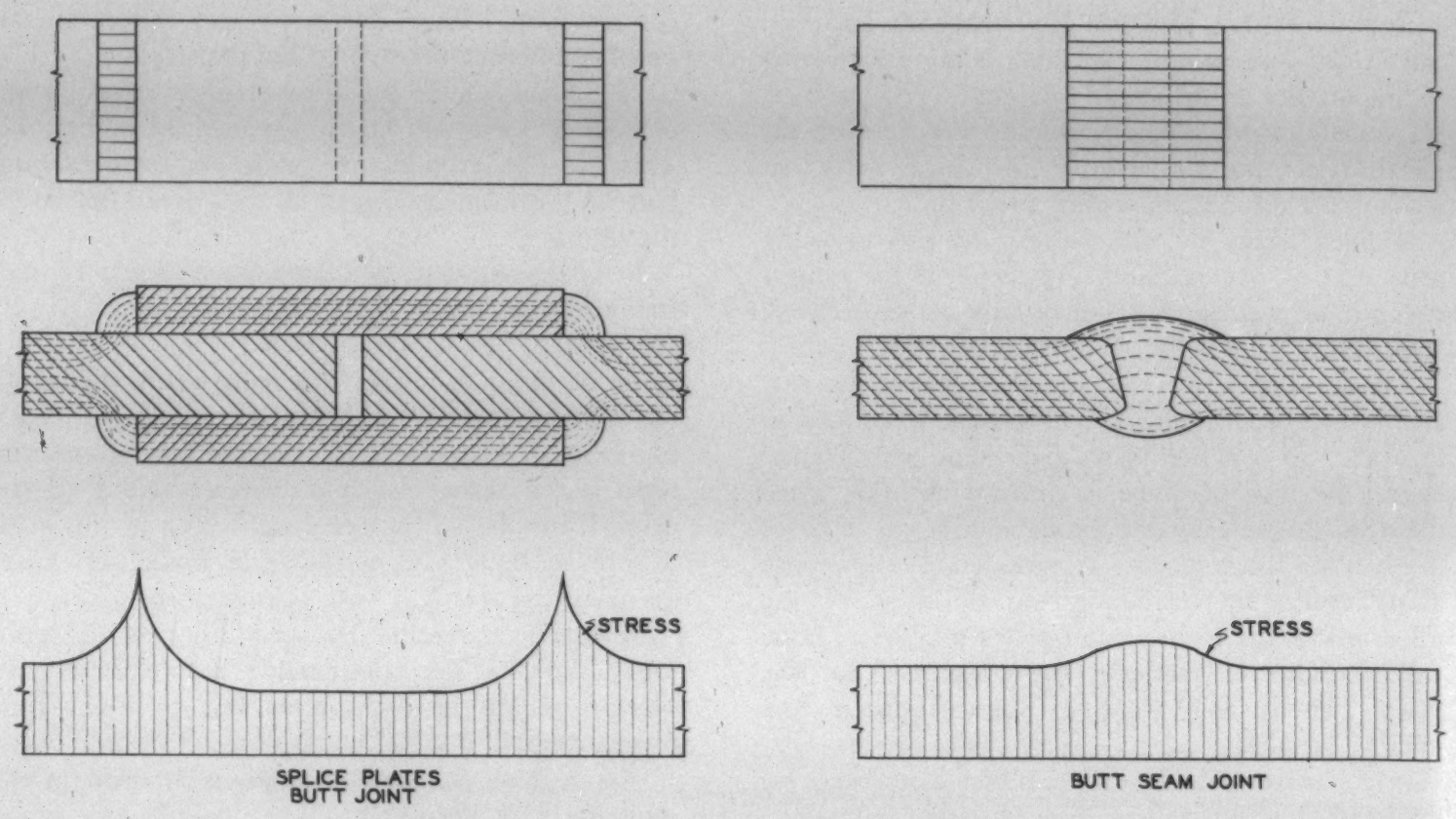
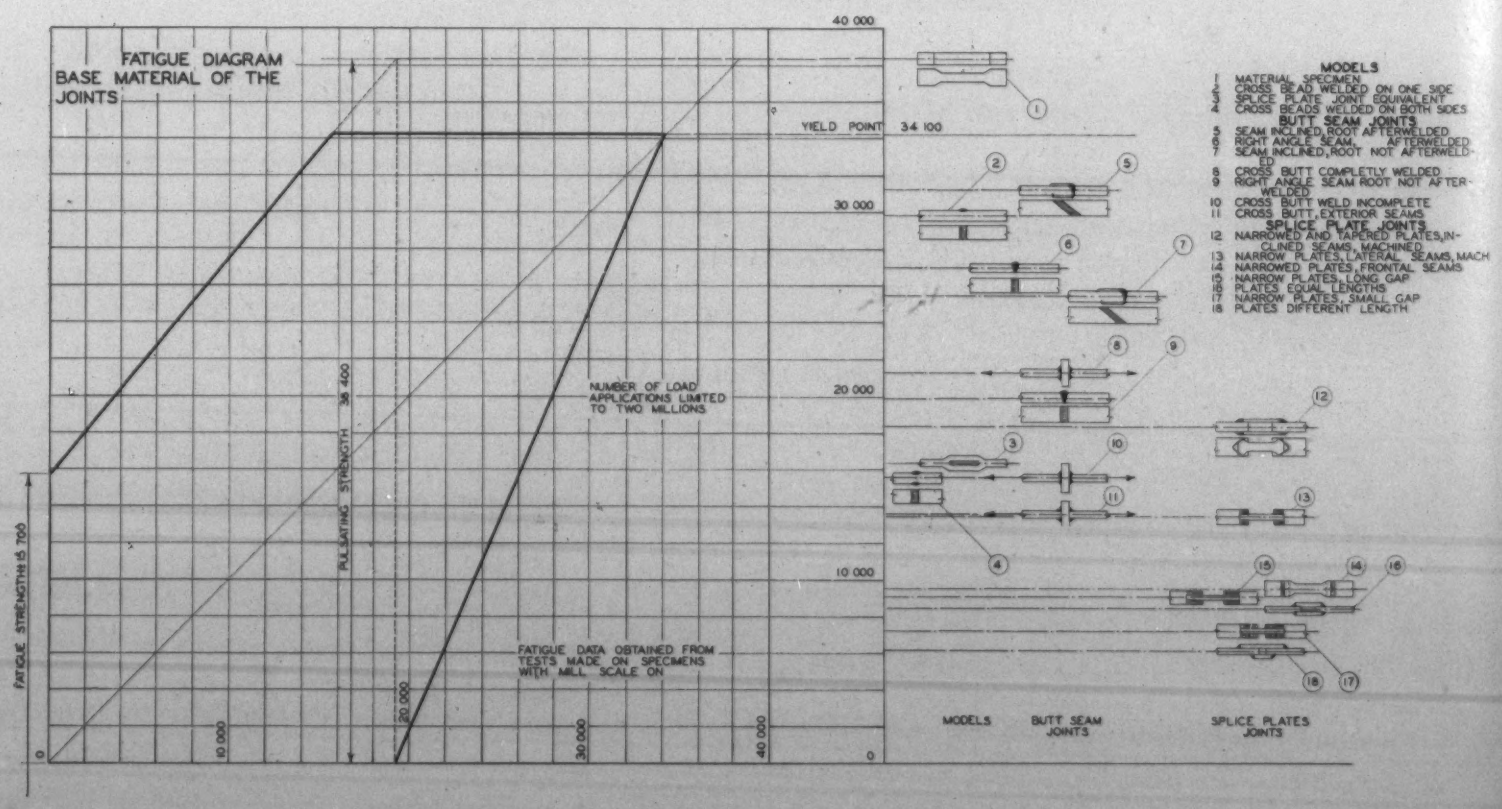


Fig. 11. Flow of stress in welded joints.

Fig. 12. Pulsating strength of welded joints.



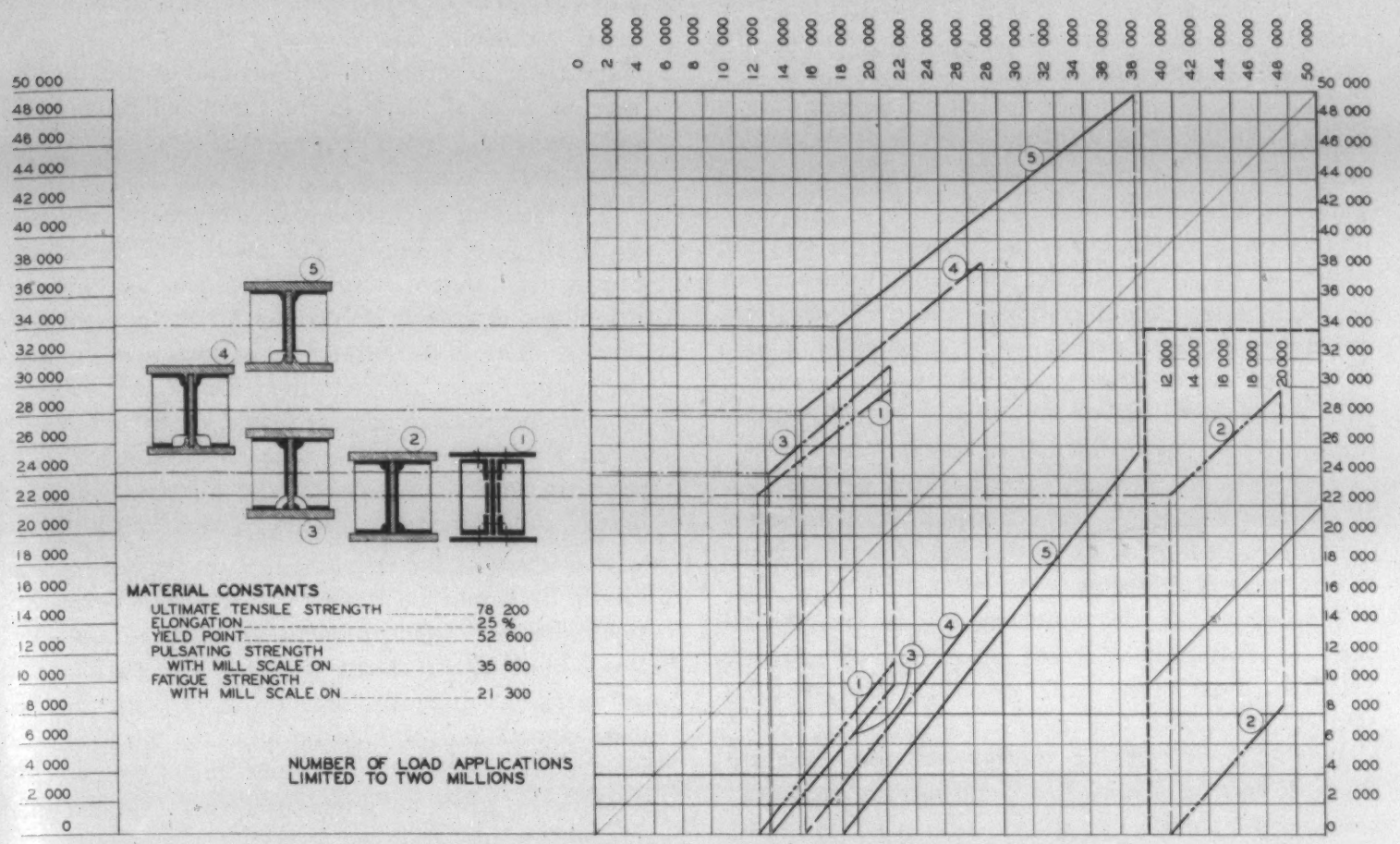


Fig. 13. Pulsating strength of welded and riveted plate girders.

concentrations being reduced due to the inclined seam and the machining and afterwelding of the root of the seam. The pulsating strength is reduced if, in a similar joint with an inclined seam, the root is not machined as shown under 7. The lowest pulsating strength, shown under 9, is exhibited by a right angle butt seam joint, without afterwelding. Cross-butt welded joints are exhibiting the highest pulsating strength, shown under 8, if the connection areas are completely welded; lower pulsating strength, shown under 10, will be obtained if part of the connection area is left open, resulting in increased stress concentrations; the lowest strength of such joints, shown under 11, is obtained if the connection is made by external seams leaving open the whole area of the plate; the high stress concentration occurring in such a joint is obvious.

The splice plate welded joints exhibit the lowest pulsating strength. The strength of the joint shown under 12, in which the stress concentrations are reduced by means of inclined seams, tapered plates and machining of the outstanding ends of the seams, is somewhat higher than in case of model 3. Narrow splice plates joints with lateral seams, shown under 13, 15 and 17, exhibit different pulsating strength. The higher strength shown under 13 is obtained by reducing the stress concentration by means of machining of the seams. The improvement of 15 as compared to 17 is due to a larger gap resulting in a less abrupt change in the stress flow. The lowest pulsating strength is exhibited by frontal seam splice joints 14, 16 and 18. The high stress concentrations of such joints, as shown on Fig. 11, are responsible for these conditions. The narrowed splice plates are improving somewhat the conditions of the joint 14; the joint 18, with splice plates of different length, has the highest stress concentrations, higher than the joint 16 with splice plates of equal length.

The radical difference between riveted and welded joints, and in particular the superiority of butt seam welded joints, and the inferiority of splice plates welded joints is a striking illustration of the importance of properly conducted fatigue tests of structural elements.

Welded and Riveted Plate Girders

The further extension of fatigue investigation leads into the determination of fatigue properties of more complicated structural elements. The results of pulsating strength investigation of welded and riveted plate girders made by Schulz and Buchholtz are briefly summarized in Fig. 13. The pulsating strength of five different girders, made of the same high grade steel and tested in bending, are shown on the left half of the figure; the pulsating strength for different degrees of pulsation are shown on the diagram on the right half of the figure. All girders were similar, having stiffeners at supports and at two points between, at which the loads were applied.

The highest fiber stress was evaluated by using the standard flexure formulas.

Under 1 is shown the pulsating strength of a riveted girder. The welded girder under 2, which is similar to the riveted girder, exhibts the same pulsating strength.

The complicated stress conditions at the meeting planes of the web, stiffener and girder plates result in high stress concentrations; the welding seam penetrates the base material and the penetration zone is weaker as compared with the original material; this weakening is of no importance in compression areas but may be detrimental in tension areas.

The pulsating strength therefore may be increased if, as shown under 3, the stiffener plate weld seams are interrupted so as to permit the straight passage of the web plate seams.

Elimination of the influence of the penetration zone of longitudinal seams by means of specially profiled cover plates still increases the pulsating strength, as shown under 4.

Finally, a remarkable increase of the pulsating strength may be obtained by omitting the cross-weld seams at the tension part of the cover plate, as shown under 5.

The striking superiority of a properly designed welded plate girder if compared with conventional riveted girders is made still clearer by comparing the pulsating strength diagram under 5 with that under 1.

VI. CONCLUSIONS

Until very recently the structural engineer took a purely academic viewpoint with reference to fatigue problems. The idea was that they are of no importance in structural designs and should be considered, if at all, only in the most modern branches of mechanical engineering—the aeronautical and automobile industry.

The trend of engineering development is the same as of all exact sciences. The increase of knowledge brings the different branches of science or engineering closer together. It becomes clearer as time goes on that there is no difference, in so far as the basic design principles are concerned, between the design of a bridge or a railroad car frame, or an automobile, or an airplane body. The only real difference is the limit to which it is economically necessary to go in details and refinements in design and fabrication.

It is obvious, for instance, that under present conditions it would be useless to give a lengthy consideration to fatigue problems in most parts of steel frame building structures. But it is also obvious that in so far as, for instance, bridge trusses, and in particular modern welded bridges, are concerned, no satisfactory design can be made unless proper consideration is given to fatigue problems. The progress in light weight railroad cars, in automobiles and airplanes can hardly be visualized without the most painstaking study of fatigue phenomena. Testing grounds may be a short cut for some time, but more scientific methods are forced upon the designer.

The results of the investigations of metallurgists and material testers must be applied to the elementary parts and to complete engineering structures. Such work was started by designing engineers in structural laboratories, and undoubtedly will be continued, changing gradually the fatigue studies from an interesting academic to an intensely practical subject.

Letters

TO THE EDITOR

Austempering or What

To the Editor: The article on austempering by E. E. Legge in the August issue of METALS AND ALLOYS points out many of the valuable practical applications of this method of heat treatment. It is not, however, generally recognized that the first large-scale use of this system was carried out by the American Chain Co. in 1928 in its study of the mechanical properties of heat-treated wire with particular emphasis on high-strength material for suspension bridges.

In order to study the entire range of quenching in a hot rather than a cold bath, the American Chain Co. carried out, under my direction, an extensive series of tests in which carbon steel of approximately eutectoid composition was quenched in lead, molten salt and hot oil. The phenomena of stable austenite and the control of the austempering process were discovered in the course of this work and a description of a portion of the work, together with photographs of the austempering structures, was published by

Dartrey Lewis in the 119th volume of the British Iron and Steel Institute in 1929 under the title, *"The Transformation of Austenite into Martensite in a 0.8 per cent Carbon Steel."*

The maximum point in combined ductility and tensile strength was determined and the famous but ill-fated, heat-treated bridge wire was prepared by an austempering process. The final commercial failure of this wire was in no way connected with the extremely desirable combination of strength and ductility which resulted from the austempering operation.

The production method used for producing heat-treated bridge wire involved the use of hot oil at about 240 deg. F. rather than molten salt. As this process was described in the paper by Swanger and Wohlgemuth in the *Proceedings of the A. S. T. M.*, Vol. 36, Part II, p. 41, 1936, entitled, *"Failure of Heat-Treated Steel Wire in Cables of the Mt. Hope, R. I., Suspension Bridge,"* the wire was quenched in oil at 240 deg. F. for 90 seconds. Magnetic tests were carried out to determine that at the end of this time the wire was still essentially non-magnetic, soft and ductile. A longer time, however, would result in martensite as would an air cooling from the oil temperature.

In the production line, this substantially austenitic wire was then treated in lead for 18 seconds at 840 deg. F. The resulting structure had mechanical properties very similar to those noted by Mr. Legge for steel of this composition, the particular characteristic being very great ductility as measured by reduction of area or the bend test. In our case the wire could be wrapped around a mandrel of its own diameter. The occasional failure to wrap at this diameter was associated with defective surface rather than defective structure.

The fact that the method was used in large-scale production before the complete investigation by Davenport and Bain, does not in the least detract from the importance of this classic investigation. It merely illustrates that an empirical development for production purposes usually precedes rather than follows, a complete laboratory investigation of a new field. As has been mentioned before, the patenting process itself is merely an early practical use of one region of the austempering technique.

It might also be of interest in this connection to note that a very considerable amount of work was done in 1929 in attempting to apply this method of heat treatment to the preparation of ball-bearing products but without any marked improvement in the fatigue life of such products.

A. V. DE FOREST.

Mass. Institute of Technology,
Cambridge, Mass.

Corrosion of Zinc

TO THE EDITOR: The article by Messrs. Anderson and Fuller on the "Corrosion of Zinc" published in the September number of METALS AND ALLOYS has interested me very much because of some work I have done using X-rays on the corrosion products from galvanized sheets exposed to the atmosphere under various conditions.

I have found that the products are mainly zinc oxide, and basic zinc carbonate. Under certain conditions I have obtained a corrosion product containing a very large amount of zinc hydroxide, together with zinc oxide. Anderson and Fuller state on page 285, left column, 7 lines below the Note, that the initial corrosion product might be zinc hydroxide although it has decomposed into oxide before X-ray examination. This zinc hydroxide was apparently stable.

In the summary the authors state that the "composition of the water corrosion product was found to be $4\ ZnO\ .\ CO_2 4H_2O$" which formula has been arrived at by chemical analysis. The pattern shown in the Table under "Formed by Air Corrosion of Zinc" resembles closely interplanar spacings and relative intensities of $2\ ZnCO_3 . 3Zn(OH)_2$[1]. This formula has been checked by crystal analysis[2] which would make it a better criterion than just chemical analysis. The authors have analyzed basic zinc carbonates (page 284) with the formula $5\ ZnO.2CO_2.4H_2O$, which, rearranged, becomes $2\ ZnCO_3.3Zn(OH)_2.H_2O$. It would be interesting to know on what grounds Messrs. Anderson and Fuller give preference to the formula $4\ ZnO.CO_2.4H_2O$.

---

[1] Courtesy of Mr. L. K. Frevel, Dow Chemical Co., Midland, Mich.

[2] W. Feitknecht. Helv. Chim. Acta, Vol. 16, 1936, page 427.

Continental Steel Corp.
Kokomo, Ind.

F. R. MORRAL,
Research Metallurgist.

A Reply by the Authors

We are very glad indeed to learn of Dr. Morral's interest in our work on the corrosion products of zinc. It is not quite clear to us just what Dr. Morral means by a stable zinc hydroxide. It is probable that the initial product of aqueous corrosion of zinc at normal temperatures is the hydroxide. On drying to a point suitable for handling in the vacuum required in the electron diffraction camera, this product evidently reverts to the oxide form. It is difficult for us to conceive of a stable zinc hydroxide under conditions of drying.

The choice of a formula to express the composition of basic zinc carbonate is apparently not clear-cut. Our expression of the formula as $4ZnO\ .\ CO_2\ .\ 4H_2O$ was merely an attempt to express the ratio of zinc oxide, carbon dioxide and water which we found by chemical analysis. We believe it is fully explained in the paper that since the production of the basic carbonate takes place by the production first of zinc oxide and the later carbonation of this material, a wide range of possible carbon dioxide contents is possible depending upon how deeply the carbonation has penetrated into the individual particles of zinc oxide. The precipitated basic carbonate to which the formula $5ZnO\ .\ 2CO_2\ .\ 4H_2O$ was given actually had a higher CO_2 content than the corrosion product to which the formula $4ZnO\ .\ CO_2\ .\ 4H_2O$ was assigned. The difference between the two to our minds resides in the probability that the corrosion product still contained some uncarbonated zinc oxide.

E. A. ANDERSON and M. L. FULLER.

Palmerton, Pa.

A "Bourbon" Spring

Note in METALS AND ALLOYS, Vol. 10, July 1939, page MA 396:

A pressure gage with "bourbon" spring!

W. D. WASHBURN

The Solvay Process Co.
Hopewell, Va.

EDITORIAL *(Continued from page 357)*

at the rate indicated by the activity of the latter part of 1939!

The metal industries have enjoyed much the same degree of long-awaited activity as have the chemical industries, and as a result, the technical staffs have been so busy with production problems that many plans for development of improvements and of new products have been laid on the shelf. In six months the executives who have ordered or approved this hiatus may wish they hadn't, for there may be a slump in which the demand for the old-line products again drops to depression levels. At that time it would be very nice to have something better to offer.

Until the clammy hand of the present administration is definitely pried loose from the neck of private enterprise, a continued upward trend with no sudden slumps, can be expected only by incurable optimists.

Since funds for development and research are available in a period such as this, the only reason why a hiatus in their prosecution need intervene, is lack of man power. We hear of many interrupted projects in the technical laboratories of industry because of lack of man power through diversion to what momentarily appear more pressing problems. You can't go out and hire development and research men to take up these problems and expect them to produce results in a few days or months. Real problems aren't solved by people who haven't lived with them a while. The time lost by diversion of the energies of those who have been living with them can never be made up.

So it seems to us that when the next slump comes, those who will be in the best shape to meet it are those who had already so divorced their research and development crew from the production crew that the former were not diverted in their efforts, but went right on with the problems whose solutions are needed to build the bulwark of lower costs and better products that will insure sales even in a slump.

When it actually starts to rain, it's too late to buy the umbrella of previous development work and it's not effective to scold the poor provider at that time. It is in order to sound the word of warning when the sun is shining and when only negligence and not lack of funds prevents laying in the umbrella.

A good New Year's resolution for 1940 would be to set up research and development on the organization chart as the one group to be kept intact, undiverted and preferably augmented. That is the most practical way of getting ready for the time when the clouds gather again. And who can feel confident that they won't?—H.W.G.

Powder Metallurgy

Many of those who attended the National Metal Exposition in Chicago were impressed as well as enlightened as to the progress which is rapidly being made in powder metallurgy. Three organizations which are active in this field displayed in their booths not only various metals in powder form but also some of the many products which are being made commercially or are being experimented on. The revelations were rather astounding and decidedly impressive. The alloys involved are numerous and the products made were varied in nature and applications.

One fact was evident—the probability in the near future of the production in this country of a pure powdered iron on a fairly large commercial scale. Details of this development are not yet available but its importance was not minimized. It was emphasized by those interested that some highly important products are possible using a relatively pure iron as a base.

Powder metallurgy has its limitations of course and it is not claimed to be a panacea. Undoubtedly it has a brilliant future and developments in this field will be closely followed.—E.F.C.

Tin at 5 Cents a Pound!

To the Editor: From the *N. Y. Times*, Sunday, Nov. 12.

TIN REACTS SHARPLY

The great percentage decline has been in tin, which in the middle of September reached 7½ cents a pound and is now back to 5 cents. One of the reasons tin shot up is the fact that it is an imported commodity, but enlarged export quotas served to allay fears of a possible shortage.

Well, a good 5c pound of tin would be something.—H.W.G.

A New Corrosion Concept?

A bulletin put out by a commercial company states: "Stainless steel is unquestionably the best material for floats as it is not affected by most acids or chemicals . . . etc. Further, it is non-magnetic, thus avoiding pitting due to electrolysis, should this condition be present."

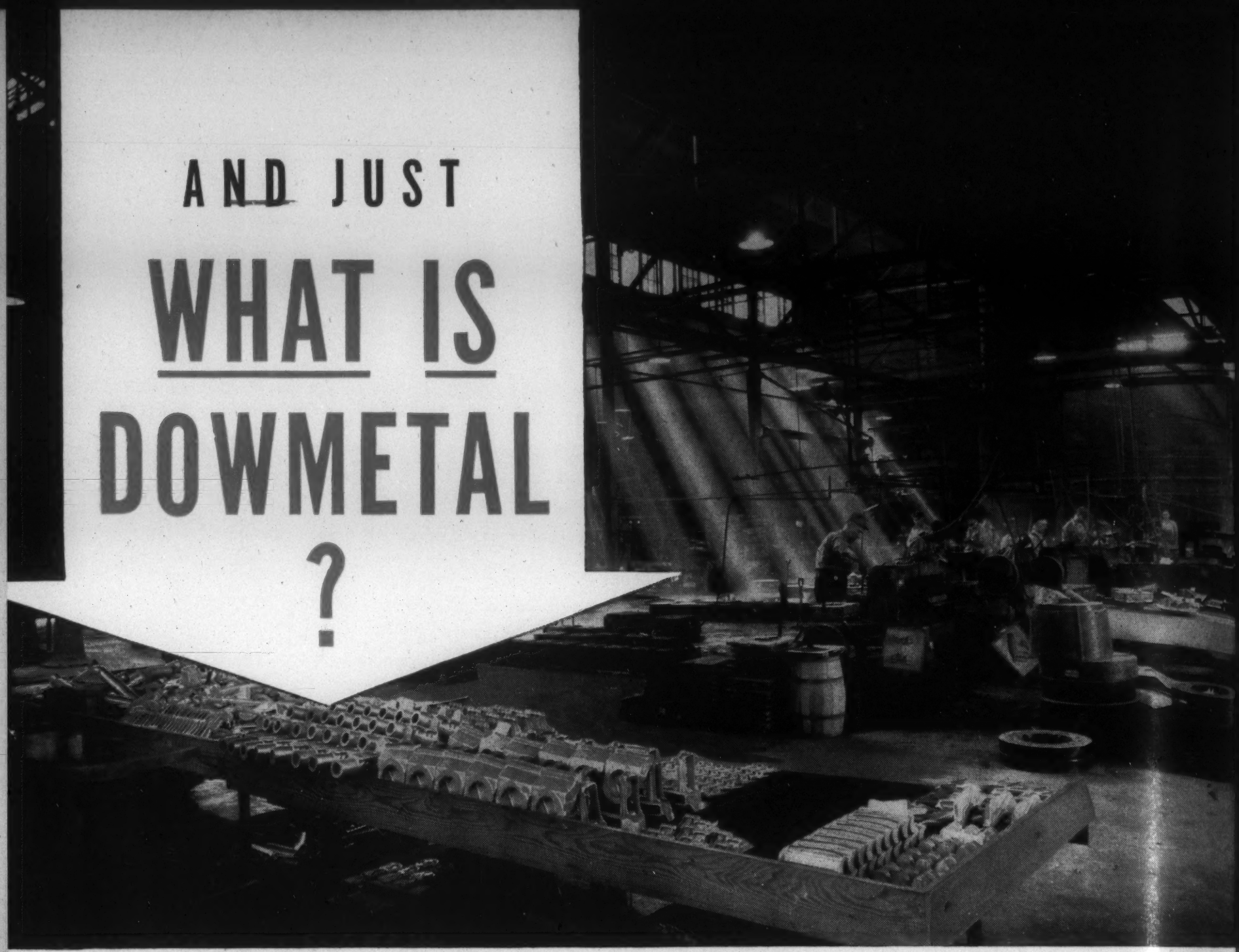
W. D. WASHBURN

The Solvay Process Co.
Hopewell, Va.

PREVIEW SECTION

of the

NATIONAL METAL CONGRESS



DOWMETAL* is the trade name for a group of magnesium alloys all containing 90-98% magnesium. Within this range, specific compositions have been developed to meet the varying needs of industry.

Magnesium is an elemental metal and, just as iron, copper, tin, zinc, and aluminum have their basic uses and functions in the metal working fields, so has magnesium. Where *extreme* lightness (magnesium is ⅓ lighter than any other metal commonly used) plus great strength and durability are required, magnesium alloys meet the specifications as no other metal can. They can be fabricated by all common methods—rolling, forging, welding, extruding, die casting, sand casting, and stamping; and are the easiest of all metals to machine.

DOWMETAL'S use in both single unit and mass production operations allows manufacturers to produce products that are easier to handle, cut power, time and labor requirements or reduce dead, useless weight. These advantages are reflected in the enthusiastic acceptance of magnesium alloys.

Visit the Dowmetal Booth at the National Metal Congress and Exposition in Chicago, October 23 to 27.

Write today for the booklet, "Industry's Lightest Structural Metal." It is a complete and concise discussion of magnesium alloys—their properties, specifications and fabrication. It illustrates graphically the wide range of applications in which industry is taking advantage of DOWMETAL'S extreme lightness.

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Contents

Introduction . . . . . A 9

American Society for Metals A10

Iron and Steel Division of AIMME A12

Institute of Metals Division of AIMME A12

American Welding Society A14

Wire Association A16

Floor Plan, National Metal Exposition A18

List of Exhibitors A19

Ten-Year Reviews A23

MEEHANITE

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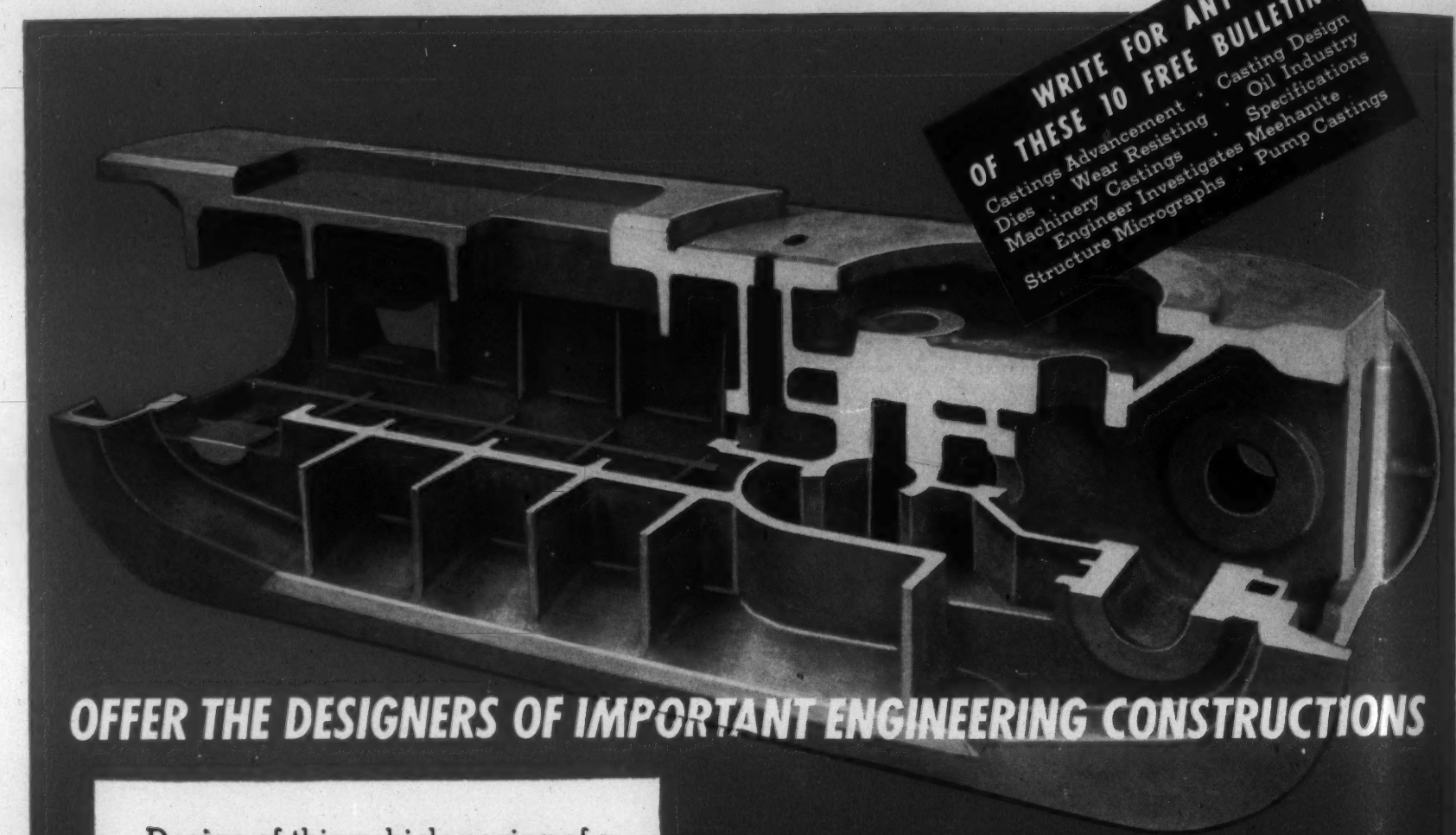

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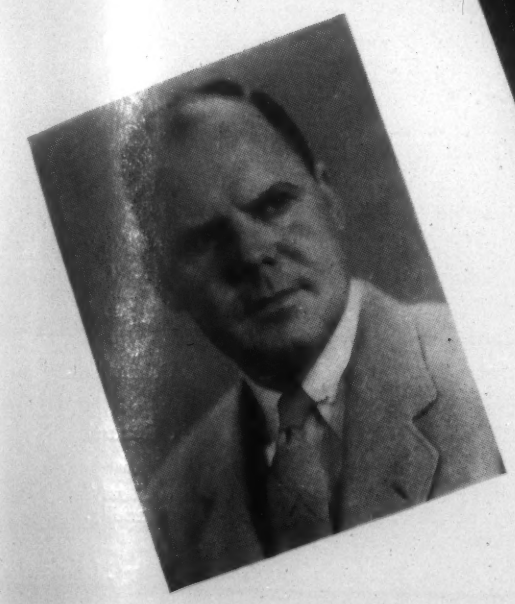
INTRODUCTION

WM. P. WOODSIDE
PRESIDENT—A.S.M.



J. P. GILL
VICE-PRESIDENT—
A.S.M

International Amphitheatre — Chicago — This will house the National Metal Exposition

IN 1935, OR FOUR YEARS AGO, the National Metal Congress was held in Chicago. This year, the twenty-first annual Congress will again meet in Chicago in the same locations as in 1935. This year the Congress is scheduled for Oct. 23 to 27, with the Palmer House as the headquarters and the International Amphitheatre housing the National Metal Exposition.

Participating Societies

As in recent years, there will be four technical societies participating in the Congress—the American Society for Metals, the American Institute of Mining and Metallurgical Engineers, the American Welding Society, and the Wire Association. The A. S. M. is the sponsor society.

These four organizations have scheduled technical sessions during the Congress. Some 135 papers and lectures by leading metallurgists, metallurgical engineers, and prominent industrialists and scientists will be delivered. Each society has some special feature in its programs. The tentative list of papers will be found on other pages.

The Exposition

As in 1935, the large metal exposition will be held in the International Amphitheatre. It is expected that this year's "steel show" will exceed in size and scope any previous one. On other pages will be found a list of the exhibitors and the floor plan of the amphitheatre.

Special Lectures

Four years ago, there was instituted as a regular feature, a series of educational lectures. This year, E. C. Bain, of the U. S. Steel Corp., will deliver a series as will also Prof. G. M. Enos of the University of Cincinnati. These lectures have proved a magnet in the past and those this year will be of a high order. Another attraction is the Campbell Memorial lecture by E. S. Davenport of the U. S. Steel Corp. The A. W. S. and the A. I. M. E. also have lectures scheduled.

A special program of plant visitations has been arranged.

A 10-Year Review

In place of publishing a detailed list of the exhibitors and what they will exhibit, we are substituting a series of reviews of 10 years of metallurgical progress. These follow the page of the list of the exhibitors. We commend their careful reading for they are contributed by our Editorial Advisory Board, the staff and a few other leaders in certain fields. One of the members of the Board, O. W. Ellis, was prevented from contributing by absence in Europe.

Appended to each review is a partial list of related articles which have appeared in METALS AND ALLOYS in the last decade.

Technical Program of the

American Society for Metals

ONE OF THE LEADING EVENTS of the National Metal Congress is the annual technical program of the sponsor society, the American Society for Metals.

The program for this year's congress is made up of about 50 papers by many of the leading American metallurgists. The sessions commence on Monday Oct. 23, and continue each day through Friday, Oct. 27. Some simultaneous sessions have been scheduled for certain days. The morning sessions are to be held at the Palmer House, the headquarters, and the afternoon sessions at the National Metal Exposition.

A feature of the convention is a symposium on "Precipitation Hardening." Another highlight is a series of afternoon lectures by E. C. Bain, assistant to the vice president in charge of research, U. S. Steel Corp., Pittsburgh. Prof. G. M. Enos, University of Cincinnati, Cincinnati, Ohio, will deliver a series of evening lectures on macroscopic, and other visual, examination of steel.

The outstanding feature of the week is the Campbell Memorial Lecture by E. S. Davenport, U. S. Steel Corp. Research Laboratory, Kearny, N. J.

The papers, tentatively scheduled to be delivered during the convention, are as follows:

"Impact Properties of Some Low Alloy Nickel Steels at Temperatures Down to —200 Deg. F.," by T. N. Armstrong and A. P. Gagnebin, International Nickel Co.

"The Effect of Titanium on the Macro-Structure and Grain-Coarsening Temperature of Forging Steel," by G. F. Comstock, Titanium Alloy Mfg. Co.

"Introductory Study of the Nitriding of Hardened High-Speed Steel by the Use of Molten Cyanides," by J. G. Morrison, Landis Machine Co., and J. P. Gill, Vanadium-Alloys Steel Co.

"Some Practical Notes on High-Speed Steel Forgings," by W. H. Wills, Allegheny-Ludlum Steel Corp.

"The Stress-Strain Characteristics of the Torsion Impact Test," by O. V. Greene and R. D. Stout, Carpenter Steel Co.

"The Influence of Magnetic Fields on Damping Capacity," by E. R. Parker, General Electric Co.

"The Interrelation Between Stress and Strain in the Tensile Test," by E. J. Janitzky and M. Baeyertz, Carnegie-Illinois Steel Corp.

"The Fatigue Resistance of Steel as Affected by Acid Pickling," by G. L. Kehl and C. M. Offenhauer, Lehigh University.

"Creep Rates From Tests of Short Duration," by J. J. Kanter and E. A. Sticha, Crane Co.

"Characteristics of 5 and 7 Per Cent Chromium Steels with Varying Molybdenum and Vanadium Content," bv W. G. Hildorf, Timken Roller Bearing Co., and C. L. Clark and A. E. White, University of Michigan.

"Stress Corrosion-Cracking of the Austenitic Nickel Steels and Its Industrial Implications," by J. L. Miller, Armour Institute of Technology, and J. C. Hodge, Babcock & Wilcox Co.

"Ferromagnetic Austenite," by L. P. Tarasov and E. R. Parker, General Electric Co.

"An Analysis of Machinability Data From Cold-Finished and Heat-Treated S.A.E. 1045 Steel," by O. W. Boston and W. W. Gilbert, University of Michigan.

"A Discussion of Lead-Bearing Steel," by F. J. Robbins and G. R. Caskey, Bliss & Laughlin, Inc.

"Precipitation Hardening Characteristics of High Purity Aluminum-Copper and Aluminum-Copper-Iron Alloys," by H. Y. Hunsicker, Aluminum Co. of America.

"Drawing of Aluminum," by L. J. Weber and J. T. Weinzierl, the Aluminum Cooking Utensil Co.

"Annealing of Low Carbon Rimmed, Aluminum-Killed and Silicon-Killed Steels," by W. P. Wallace, Columbia Steel Co., and R. L. Rickett, U. S. Steel Corp.

"The Prevention of Flakes by Holding Railroad Rails at Various Constant Temperatures," by R. E. Cramer and E. C. Bast, University of Illinois.

"Selection of Steel and Heat Treatment for Spur Gears," by H. B. Knowlton and E. H. Snyder, International Harvester Co.

"Time Quenching," by J. L. Burns and Victor Brown, Republic Steel Corp.

"A Test Method for the Evaluation of Aqueous Quenching Media for Steel Hardening," by F. W. Trembour and Howard Scott, Westinghouse Electric & Mfg. Co.

"Hardenability Variations in Alloy Steels: Some Investigations with the End-Quench Test," by G. T. Williams, Cleveland Tractor Co.

"A Hardenability Test for Shallow Hardening Steels," by W. E. Jominy, General Motors Corp.

Annual Meeting and Campbell Memorial Lecture, by E. S. Davenport, U. S. Steel Corp., Kearny, N. J.

"The Effect of Hardness and of Temperature on the Strength, Ductility, and Toughness of a Heat-Treated Carbon Steel," by S. W. Lyon, University of Illinois.

"Hardness Characteristics of Some Median Carbon S.A.E. Steels," by P. Kalin and C. H. Lorig, Battelle Memorial Institute.

"The Accelerating Effect of Certain Metallic Elements on Graphitization," by H. A. Schwartz, V. Fiordalis, J. L. Fisher, J. F. Shuman and M. F. Trinter, National Malleable & Steel Castings Co.

"Transformation of Austenite on Quenching High Purity Iron-Carbon Alloys," by T. G. Digges, National Bureau of Standards.

"Kinetics of the Austenite-Martensite Transformation in Steel," by A. B. Greninger and A. R. Troiano, Harvard University.

"The Mechanical Properties of the Isothermal Decomposition Products of Austenite," by M. Gensamer, E. B. Pearsall and G. V. Smith, Carnegie Institute of Technology.

"The Spheroidizing of Steel by Isothermal Transformation," by P. Payson, W. Hodapp and J. Leeder, Crucible Steel Co. of America.

"Bright Hardening of Tool Steels Without Decarburization or Distortion," by J. R. Gier and Howard Scott, Westinghouse Electric & Mfg. Co.

"Hardness Conversion Relations for Hardened Steels," by H. Scott and T. H. Gray, Westinghouse Electric & Mfg. Co.

"Hardenability Studies on Tool Steels," by A. J. Scheid, Jr., Columbia Tool Steel Co.

"Nickel-Tungsten System," by W. P. Sykes and F. H. Ellinger, General Electric Co.

"The Effect of Humidity of Air on the Oxidation of a Low Carbon Steel," by C. A. Siebert, University of Michigan, and H. G. Donnelly, Wayne University.

"Heat Etching as a Means of Revealing Austenite Grain Size," by M. J. Day and J. B. Austin, United States Steel Corp.

"The Tempering of High-Speed Steels," by Morris Cohen and P. K. Koh, Massachusetts Institute of Technology, Cambridge, Mass.

"Introduction to Precipitation Hardening," by Zay Jeffries, General Electric Co., Cleveland.

"The Application of Solid Solution and Precipitation Hardening Effects in Aluminum Alloys," by L. W. Kempf, Aluminum Co. of America.

"Precipitation-Hardening of High Purity Binary and Ternary Aluminum-Copper Alloys," by W. L. Fink, D. W. Smith and L. A. Willey, Aluminum Co. of America.

"Precipitation Hardening in the Heavy Alloys," by W. P. Sykes, General Electric Co.

"Age-Hardening Copper Alloys," by D. K. Crampton, Chase Brass & Copper Co.

"Age-Hardening of a Copper-Cobalt and a Copper-Iron Alloy," by R. B. Gordon, Westinghouse Electric & Mfg. Co., and M. Cohen, Mass. Inst. of Tech.

"Precipitation Hardening in Nickel-Base and Precious Alloys," by N. B. Pilling and A. M. Talbot, International Nickel Co., Bayonne, N. J.

"Aging in Iron and Steel," by R. L. Kenyon and R. S. Burns, American Rolling Mill Co.

"The Role of Strain in Precipitation Reactions in Metals," by R. H. Harrington, General Electric Co.

"The Mechanism of Precipitation Hardening—The Theory of Age-Hardening," by R. F. Mehl, Carnegie Institute of Technology.

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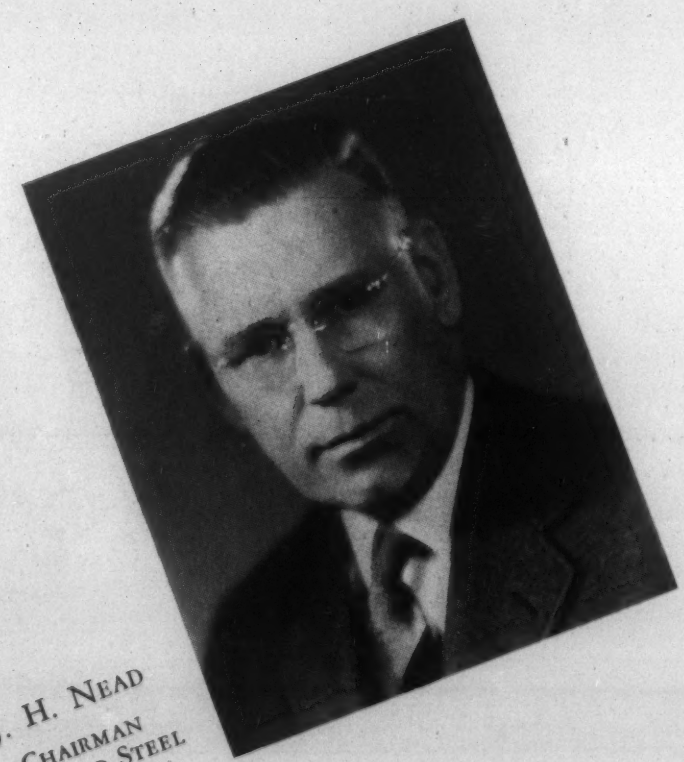
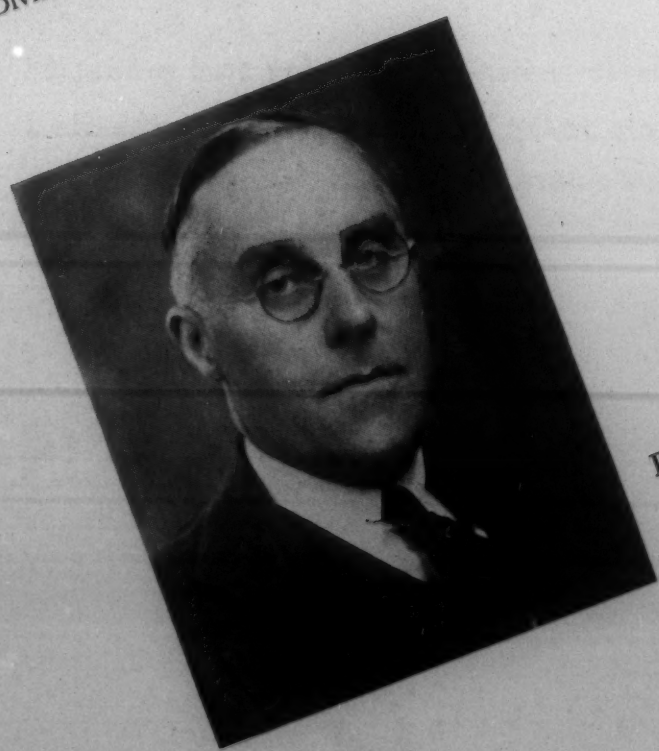
Technical Program of the

Metal Divisions of the A.I.M.E.



J. H. NEAD
CHAIRMAN
IRON AND STEEL DIVISION



ROBERT H. LEACH
CHAIRMAN
INSTITUTE OF METALS DIVISION

AN EXCELLENT PROGRAM of some 22 technical papers has been prepared for the sessions of the iron and steel and the non-ferrous divisions of the American Institute of Mining and Metallurgical Engineers. The various sessions commencing on Monday and ending on Wednesday, Oct. 25, during the Congress, are to be held at the Blackstone Hotel.

The annual autumn joint dinner of the two divisions will be held Tuesday evening, Oct. 24, at which C. M. White, vice president in charge of operations, Republic Steel Corp., Cleveland, will be the principal speaker.

The technical program is tentatively as follows:

"A Laboratory Study of the Reactions Occurring Between Molten Zinc Alloys and Pressure Die Casting Equipment," by E. A. Anderson, Gerald Edmunds and C. W. Siller, The New Jersey Zinc Co.

"A High Strength Silicon Brass Die Casting Alloy," by Alan U. Seybolt and B. W. Gonser, Battelle Memorial Institute.

"The Pitting of Stainless Steels," by H. H. Uhlig, Mass. Inst. of Tech.

"Data on Pit Focii," by R. Buehl and John Wulff, Mass. Inst. of Tech.

"Beneficial Effects of Zirconium in Cast Nickel-silicon Bronzes," by F. R. Hensel, E. I. Larsen and A. S. Doty, P. R. Mallory Co., Inc.

"A Study of the Distribution of Structural and Physical Characteristics Through the Bodies of Large Castings of Gun Metal," by A. A. Bradd, College of the City of New York.

"A Study of the Distribution of Structural and Physical Characteristics Through the Bodies of Large Castings of Red Brass, by Allen M. Rahm, College of the City of New York.

"Magnetic Analyses of Transformations in a Cold Worked 18-8 Alloy," by R. Buehl and John Wulff, Mass. Inst. of Tech.

"A New Instrument for the Magnetic Determination of Carbon in a Steel Bath," by H. K. Work and H. T. Clark, Jones & Laughlin Steel Corp.

"An Apparatus for Determining the Thermo-magnetic Behavior of Slags and Some Preliminary Results Obtained With It," by B. A. Rogers and K. O. Stamm, U. S. Bureau of Mines.

"The Structure of Aluminum After Compression," by Charles S. Barrett and Leonard H. Levenson, Metals Res. Lab., Carnegie Institute of Tech.

"Recrystallization of Lead," by Paul A. Beck, American Smelting & Refining Co.

"Tensile Deformation of Critically Oriented Brass Crystals," by H. L. Burghoff, Chase Brass & Copper Co.

"The Solubility of Nitrogen in Molten Iron-silicon Alloys," by J. C. Vaughan and John Chipman, Mass. Inst. of Tech.

"Studies of Erosion of Guns," by Peter R. Kosting, Watertown Arsenal.

"The Constitution and Microstructure of Copper-rich Silicon Copper Alloys," by Cyril Stanley Smith, American Brass Co.

"The Alpha Solubility Limit and the First Intermediary Phase in the Copper-silicon System," by A. G. H. Anderson, Phelps Dodge Corp.

"A Simple Method of Thermal Analysis Permitting Quantitative Measurements of Specific and Latent Heats," by Cyril Stanley Smith, American Brass Co.

"Desulphurization of Pig Iron with Calcium Carbide," by C. E. Wood, E. P. Barrett and W. F. Holbrook, Blast Furnace Studies Section, Met. Div. Bureau of Mines.

"The Reduction of Iron Ores Under Pressure by Carbon Monoxide," by Michael Tenenbaum and T. L. Joseph, Univ. of Minn.

"Graphitization of Cementite in Cupola White Iron," by N. A. Ziegler, W. L. Meinhart and A. J. Deacon, Crane Co.

"Tensile Properties of Rolled Magnesium Alloys, I. The Binary Alloys with Aluminum, Antimony, Bismuth, Cadmium, Copper, Lead, Nickel, Silver, Thallium, Tin, and Zinc," by John C. McDonald, The Dow Chemical Co.

"Copper Embrittlement, IV," by L. L. Wyman, General Electric Co.

"The Effect of Composition Upon the Physical and Chemical Properties of 10K Gold Alloys," by Tracy C. Jarrett, American Optical Co.

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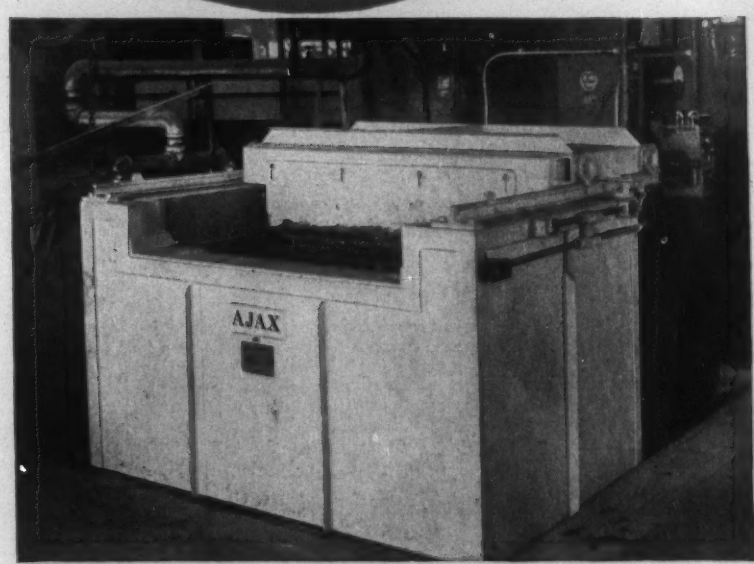

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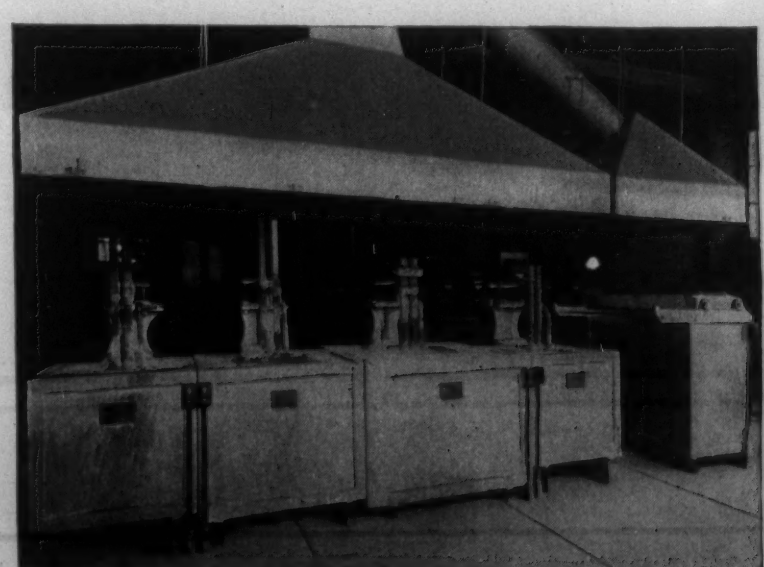

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Technical Program of the

American Welding Society

A TECHNICAL PROGRAM of about 55 papers has been prepared for the 20th annual meeting of the American Welding Society during the National Metal Congress. All sessions, running from Monday to Friday inclusive, Oct. 23 to 27, will be held at the Stevens Hotel, the headquarters. Important events include sessions on Fundamental Research, Flame Hardening and Hard Surfacing, Resistance Welding and so on. There are many simultaneous sessions.

Two evenings are devoted to conferences on Industrial Research and on Fundamental Research, respectively. The annual banquet will be on Thursday evening, Oct. 26. The technical papers follow:

"Welded Structures Under the Bureau of Yards and Docks, U. S. Navy," by C. A. Trexel, Bureau of Yards and Docks, Navy Department.

"Bonneville Dam Presents Varied Use of Welding," by Paul L. Heslop and Fred T. Downing, Corps of Engineers, U. S. Army.

"Some Aspects of the Welding of Alloy Steels," by H. J. French and T. N. Armstrong, International Nickel Co.

"An Investigation of the Spot Welding of Automobile Grade Mild Steel," by W. F. Hess and R. A. Wyant, Rensselaer Polytechnic Institute.

"Failure of Aluminum Subjected to Combined Stresses," by Joseph Marin, Rutgers University.

"Fatigue Tests of Welded Joints in Structural Plates," by W. M. Wilson and A. B. Wilder, University of Illinois.

"Welding Tubing for the Automotive Industry," by G. C. Gridley, Mechanics Universal Joint Division, Borg-Warner Corp.

"Machine Welded Sheet Metal Parts for Enameling," by Joseph C. Lewis, Associated Engineers, Inc.

"Automatic Oxy-Acetylene Welding of Oil Floats," by H. E. Lerner, Taylor Sales Engineering Co.

"Reactions in Arc Welding," by R. David Thomas, Jr. and F. H. Rhodes, Cornell University.

"Arc Welding in Controlled Atmospheres," by G. E. Doan, Lehigh University.

"The Effect of Alloying in Metallic Arc Welding," by R. W. Emerson, Westinghouse Electric & Mfg. Co.

"Manganese in Rutile-Type Coated Steel Electrodes," by E. G. Enck, Foote Mineral Co.

"Creep Tests of Arc Welded Low Carbon Steel," by N. F. Ward, University of California.

"Use of Steel Castings and Rolled Steel Plate in Welded Fabrication," by H. J. Shiffli and Emil Krecji, American Steel Foundries.

"Plate Edge Preparation for Welding," by H. E. Rockefeller, The Linde Air Products Co.

"Flow of Materials in Production Welding," by W. W. Petry, Cincinnati Milling Machine Co.

"Welding Heavy Presses," by L. J. McDonough and J. R. Henry, Clearing Machine Corp.

"Further Studies of the Spot Welding of Low Carbon and Stainless Steels," by W. F. Hess and R. A. Wyant, Rensselaer Polytechnic Institute.

"Application of Proximity Effect to Welding," by E. Bennett, University of Wisconsin.

"Contact Resistance," by F. J. Studer, Union College.

"Weld Inspection by Means of Trepanned Plugs," by W. T. Tiffin, University of Oklahoma.

"Welding of Copper," by A. P. Young, Michigan College of Mining and Technology.

"The Fabrication of Road Building Equipment," by L. L. Burger, La Plant-Choate Mfg. Co., Inc.

"Designing Construction Machinery for Production by Welding," by H. C. Hettelsater, Harnischfeger Corp.

"Cutting and Welding Stainless Clad Steel," by W. B. Keelor, Farwell Metal Fabricating Division, Farwell, Ozmun, Kirk & Co.

"Large Equipment Fabrication," by Leslie McPhee, Whiting Corp.

"Flame Hardening the Way Surfaces of Machine Tools," by Fred C. Dull, the Monarch Machine Tool Co.

"Hard Facing by Fusion Welding," by T. B. Jefferson, Marine Design Section, War Department.

"Flame Treating," by J. H. Zimmerman, the Linde Air Products Co.

"Flame Hardening From the Standpoint of the Commercial Heat Treater," by W. G. Hamilton, Accurate Steel Treating Co., Inc.

"Some Applications of the Resistance Welding Process," by C. L. Pfeiffer, Western Electric Co.

"Precision Welding by the Resistance Method," by E. J. Bates, G. J. Oswald and R. L. Haus, the National Cash Register Co.

"Spot Welding of Aluminum," by R. Kauffmann, Aluminum Francais.

"Some Studies of Flash Welding," by M. G. Yatsevitch, Watertown Arsenal.

"Welding of Boilers and Pressure Vessels," by R. T. Kernoll, Edge Moore Iron Works.

"Oxy-Acetylene Welding of Red Brass Pipe," by A. N. Kugler, Air Reduction Sales Co.

"90° Welded Nozzles, Piping—Calculations, Design and Fabrication," by F. C. Fantz, and W. G. Hooper, Midwest Piping & Supply Co., Inc.

"Extensions of Fusion Welding in Special Pipe and Pipe Fitting Applications," by E. Hall Taylor, Taylor Forge & Pipe Works.

"Engineering Fundamentals of Resistance Welding," by S. M. Humphrey, The Taylor Winfield Corp.

"High Speed Welding Assemblies," by E. W. Forkner, Federal Machine & Welder Co.

"Application and Use of Portable Spot Welders," by C. E. Heitman, Edward G. Budd Mfg. Co.

"Latest Developments in Resistance Welding," by R. T. Gillette, General Electric Co.

"Repairs to Castings and Other Steel Mill Parts," by S. S. Baumer, Bethlehem Steel Co.

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"Flame Descaling and Flame Cleaning and Dehydrating," by J. G. Magrath, Air Reduction Sales Co.

"High Spots in Ship Welding," by E. D. Debes, Bethlehem Shipbuilding Corp.

"Designing Welded Frames for Continuity," by Bruce Johnston and E. H. Mount, Lehigh University.

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"Present-Day Practice in Structural Welding," by A. L. Wilson, Mississippi Valley Structural Steel Co.

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"A Study of Welding Heat Effects," by W. A. Pearl, Armour Institute of Technology.

"Welding in the Manufacture of Valves for High Pressures and Temperatures," by W. F. Crawford and L. H. Carr, Edward Valve & Mfg. Co.

"Shrinkage of Steel Due to Welding," by Samuel T. Smetters, the Sanitary District of Chicago.

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Chicago, Oct. 23–27
Booth M-319

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Featuring — the automatic welding of thin gauge, lead-coated steel oil floats; a practical demonstration of the value of Airco's Field Engineering Service which developed this operation.

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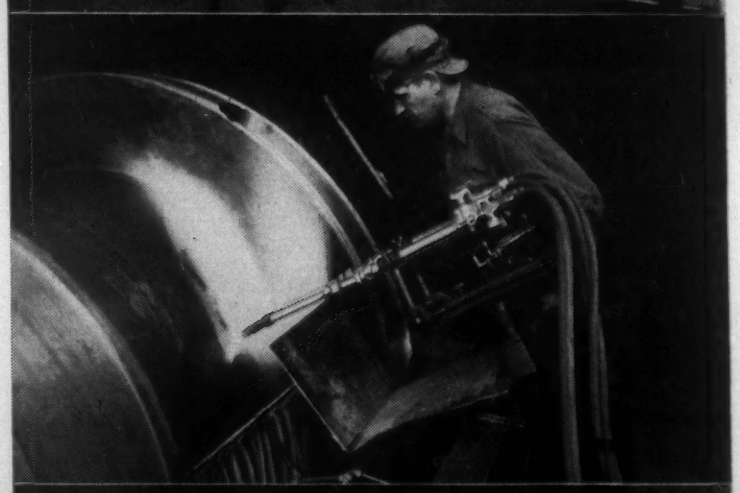
Featuring — Airco Flame Hardening Equipment, demonstrating the economy and the almost limitless application of "localized hardening" of metal parts.



Flame-Cleaning

Featuring — the equipment for surface conditioning of wrought iron and steel with Airco Flame Descaling and Flame Cleaning and Dehydrating.

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Featuring — the new Planagraph, an addition to the line of Airco Oxyacetylene Cutting Machines which fill the needs of industry for cutting steel in straight lines, arcs and circles, and irregular shapes with squared or beveled ends.

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Featuring—the complete line of Wilson Arc Welders, the machines that industry relies upon to make the arc behave. The New Wilson "Hornet" will be exhibited for the first time.

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Featuring — Aircowelding, the fast, economical pipe welding process. The Airco Portable Pipe Cutting and Beveling Machine. The Airco Portable Weld Testing Machine.

Here's your chance to quickly, conveniently see the many industrial applications of the oxyacetylene process . . . to talk over your problems with Airco engineers . . . possibly to discover how to make your product better, faster, more economically. You'll find our representatives anxious to be of assistance to you—and qualified to give you expert advice.

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Technical Program of the

Wire Association

DURING THE CONGRESS the Wire Association will hold its annual convention at which about 12 papers will be presented before both its ferrous and non-ferrous divisions. The sessions commence on Monday, Oct. 23 and extend through Thursday, Oct. 26 at the Congress Hotel.

The Mordica Memorial Lecture will be delivered Wednesday afternoon, Oct. 25, by Dr. S. A. Braley, Mellon Institute, Pittsburgh. That evening a smoker is scheduled. The tentative list of technical papers follows:

"Characteristics of Mild Steel Welding," by J. C. Joublanc, Technical Director, Harnischfeger Corp.

"Boulder Dam—The World's Outstanding Transmission Line," A Lecture with Motion Pictures, by Dr. Donald M. Simmons, Chief Engr., General Cable Corp.

"Submerged Heat by Submerged Combustion," by Walter S. See, Submerged Combustion Co. of America.

"Elasticity of Spring Wire," by George Nelson, L. A. Young, Spring & Wire Corp.

"Film Manufacture of Swedish Steel Rods," by Uddeholm Co. of America.

"Coating Wire with Paper Pulp," by J. S. Little, manufacturing engineer, Western Electric Co.

"The Brazing of Copper," by L. L. Wyman, research eng., General Electric Co.

"Atmospheric Annealing of Steel Wire," by Dr. A. A. Bates, manager chemical and metallurgical div., Westinghouse Electric & Mfg. Co.

"Manufacture and Use of Stainless Steel Wire," by Stanley P. Watkins, manager, Rustless Iron & Steel Corp.

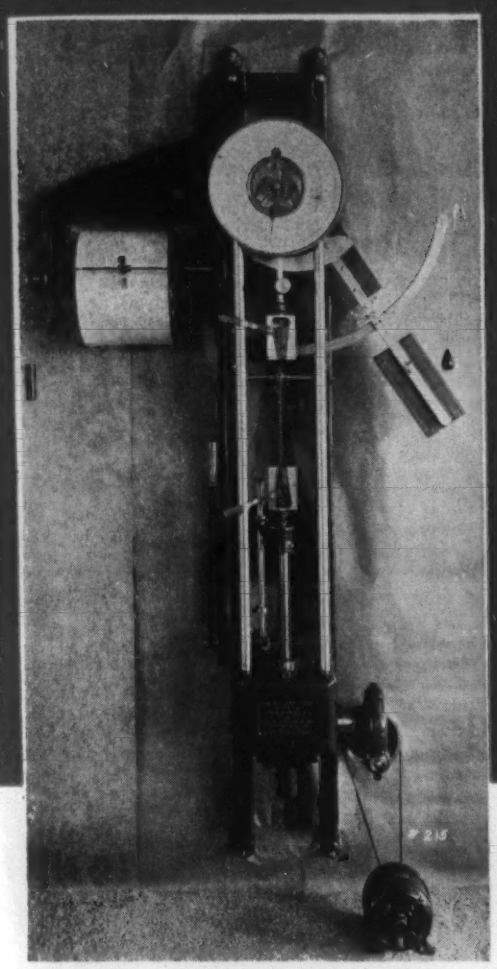
"Electrical Resistance Wires," by Dr. C. L. Mantell, technical director, Wilbur B. Driver Co.

"Manufacture of Wire Solder," by Robert A. Gardiner, president, Gardiner Metal Co.

F. O. WESTPHAL
PRESIDENT

HORIZONTAL and VERTICAL WIRE TESTING MACHINES

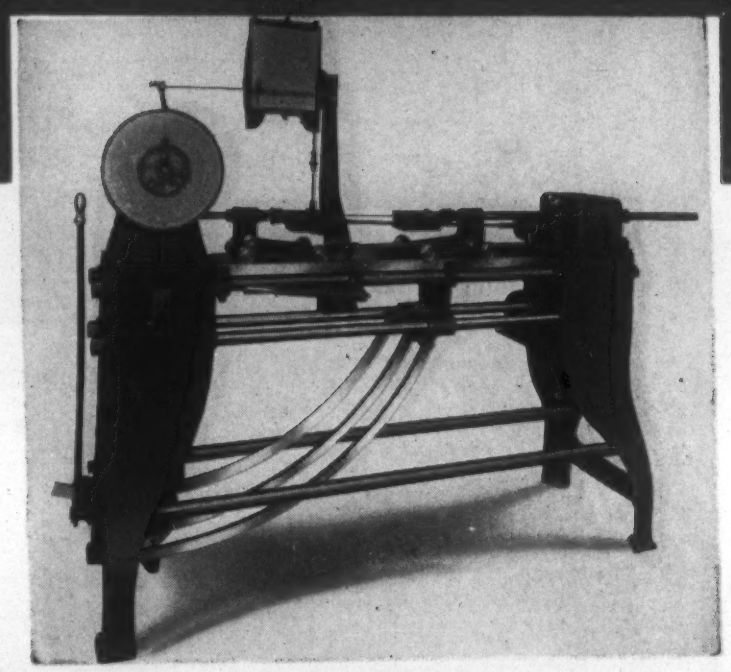
SCOTT TESTERS



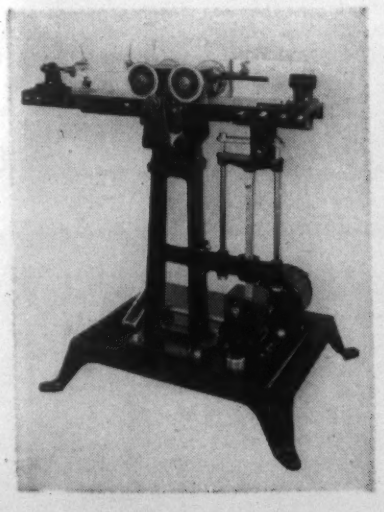
MODEL J-5

Standard for the tire wire industry, Model J-5, above, has cylindrical type recorder which magnifies stress-strain curve in ratios as high as 20 to 1. Clearly shows elastic limit, yield point, ultimate elongation and tensile strength. Capacities, 0-250 to 0-500 lbs. or 0-500 to 0-1000 lbs.

Model Q-4 (right) is of heavier construction to adapt it for tests up to 2000 lbs. Like Model J-5, it measures load by the weighted pendulum principle, and strains specimen with positive gear drive. Can be furnished with cylindrical type recorder.



MODEL Q-4



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Scott Testers offer the wire industry a range from ONE TON TO AS LOW AS 50 GR. for fine wire testing. Outstanding advantage of Scott Testers is the feature of defining the yield point by drawing the stress strain curve and showing ultimate elongation, tensile strength, and degree of hardness, at the same time.

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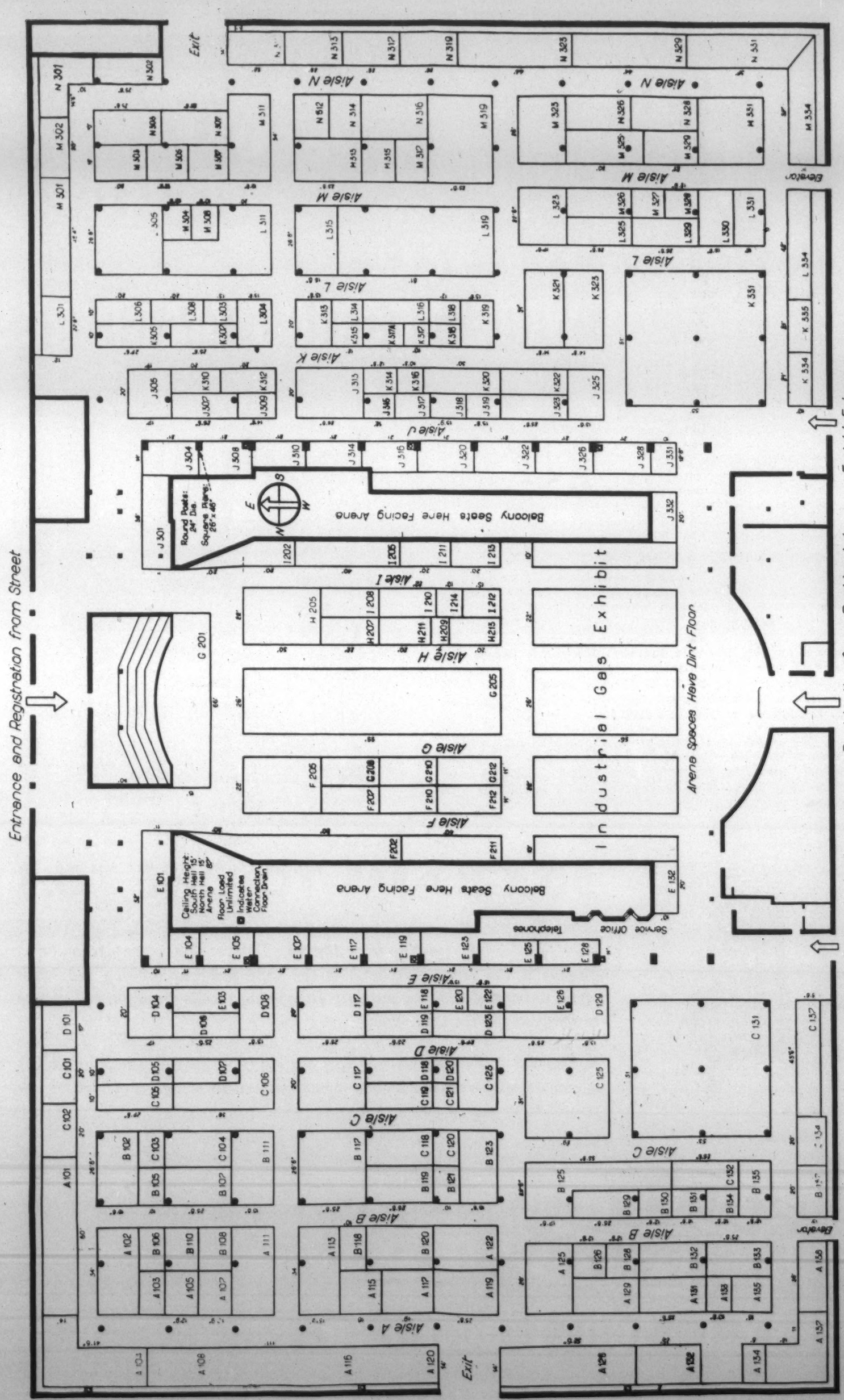

Floor Plan of the National Metal Exposition

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Ajax Electric Co., Inc., Philadelphia.—Booth A-101.
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Edgar Allen Steel Co., New York.—Booth E-120.
Alox Corp., Niagara Falls, N. Y.—Booth B-130.
Aluminum Co. of America, Pittsburgh.—Booth G-201.
The American Brass Co., Waterbury, Conn.—Booth A-104.
American Car & Foundry Co., New York.—Booth C-106.
American Chain & Cable: Andrew C. Campbell Div., Bridgeport.—Booth M-323; Page Steel & Wire Div., Monessen, Pa.—Booth M-323.
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Bliss & Laughlin, Inc., Harvey, Ill.—Booth M-305.
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Titanium Alloy Mfg. Co., Niagara Falls, N. Y.—Booth K-310.

Uddeholm Co. of America, New York.—B-134.
Una Welding, Inc., Cleveland.—Booth B-111.
Union Carbide Co., New York.—Booths L-302, M-301 and L-305.
United States Steel Corp., Pittsburgh.—Booth G-205.
Universal-Cyclops Steel Corp., Bridgeville, Pa.—Booth K-321.

Vanadium Alloys Steel Co., Pittsburgh.—Booth A-125.
Vanadium Corp. of America, New York.—Booth E-103.
Victor Saw Works, Inc., Middletown, N. Y.—Booth M-328.
Vonnegut Moulder Corp., Indianapolis, Ind.—Booth H-209.
Vulcan Copper & Supply Co., Cincinnati.—Booth A-107.
Vulcan Crucible Steel Co., Aliquippa, Pa.—Booth J-316.

Wall Colmonoy Corp., Detroit.—Booth M-327.
The Welding Engineer, Chicago.—Booth A-103.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Booth B-125.
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Wheelock, Lovejoy & Co., Inc., Cambridge, Mass.—Booth L-316.
Wilson Mechanical Instrument Co., New York.—Booth H-207.
Wilson Welder & Metals Co., North Bergen, N. J.—Booth M-319.
Wire Association.—Booth D-120.

Youngstown Sheet & Tube Co., Youngstown, Ohio.—Booth N-319.

Zeiss, Carl, Inc., New York.—Booth G-208.
Ziv Steel & Wire Co., Chicago.—Booth J-309.

Ten Years of Metallurgical Progress Reviewed

—1929 to 1939

Ten years ago—or more exactly, in July, 1929—the first issue of METALS AND ALLOYS, was published. Developments in the world of metals in that period have been exceedingly impressive. A brief but effective review of this progress was published in our July issue on the editorial page — "Time Marches On."

Partly because this year is the tenth anniversary of METALS AND ALLOYS, it has seemed appropriate to assemble and publish a series of reviews of developments in metallurgy and metallurgical engineering, covering the past ten years. Another reason is the desire to make more worth while the Preview Section of the magazine by substituting these reviews for material heretofore used, and available elsewhere.

We have another justification, if any be necessary, for such a series. It is our firm conviction that a 5-year or a 10-year review in the metal industry, or in any other, is far better and more representative of real progress than the oft-repeated annual reviews. Seldom is it the case that developments start and reach fruition in one year—their evolution and progress are usually from year to year, or over a period of years.

To present these ten-year developments, we have asked each member of our Editorial Advisory Board and of the staff to contribute. Each one of the Board is a specialist in his field and his utterances are authoritative. We have been highly fortunate in their cooperation. Our editorial director has dealt with one of several themes with which he is so familiar. Because there were a number of important fields which unfortunately, are not represented on our Board, we have asked certain leaders in these fields to contribute—they have given valuable assistance.

Manifestly all important subjects could not be embraced in this assemblage, due partly to space limitations. It has fallen to the lot of the editor to attempt to cover at least part of these as his share of the contributions. The assistant editor discusses the powdered metals, a subject with which he is keeping in close touch.

There are some 30 or more reviews in this rather impressive aggregation. We recommend them to the perusal of our readers and take some pride in them. The splendid cooperation of each contributor is gratefully acknowledged.—E. F. C.

By the Editorial Advisory Board

Die Castings

by Harvey A. Anderson

General recognition of the unique suitability of die castings for economic application in a wide diversity of products has resulted in quadrupling the volume of production during the last ten years. With the solid background of major consumption in automobiles, die cast parts have been adopted in other large unit production lines, such as telephone apparatus, household appliances, toys, radios, and typewriters, where no other method of manufacture can produce so cheaply an intricately shaped part with high grade surfaces and closely controlled dimensions.

Zinc Alloys

The applications of die castings range from strong massive radiator grilles weighing 27 lbs. each to small intricate zipper teeth weighing a fraction of a gram each. The available materials include soft corrosion-resistant tin and lead alloys, ultra-light easily machinable magnesium alloys, light corrosion-resistant aluminum alloys, the generally popular zinc alloys, and 100,000 lbs. per sq. in.-strong brass alloys. The American Bureau of Metal Statistics reports an average production of 60,000 tons of zinc base die castings annually during the last five years and an all time peak production of 88,000 tons in 1937.

The rapid growth in the production of quality die castings may be said to date from the first commercial availability of 99.99+ per cent pure zinc, which Gillett calls our first low cost super-pure metal. Other companies have followed the lead of the first "4 nines" zinc producer and one large supplier has made numerous valuable contributions to our technical knowledge of zinc alloys. The A.S.T.M. has provided an excellent forum in its die casting committee for critical appraisal of new alloys by both producers and consumers. The resulting specifications incorporate requirements based on committee sponsored corrosion tests involving hundreds of thousands of specimens.

Dependable information has been disseminated regarding the detrimental effect of contamination of zinc alloy die cast parts by thousandths of a per cent of lead, cadmium, and tin. This necessitates routine spectrographic control of alloy purity. Radiographic control of casting soundness, and pyrometric control of alloy and die temperatures are other refinements which are used in the production of low cost die castings. As a result smooth dense zinc base die castings of intricate shape and accurate dimensions are now produced regularly. These exhibit high tensile and impact strength and elongation even after ten days exposure to 95 deg. C. steam. This test, equivalent to years of exposure in the worst seacoast or industrial atmospheres, results in dimensional changes in high quality die cast parts of less than 0.05 per cent. Aluminum, magnesium and lead alloy producers have also made noteworthy contributions to the progress in alloy developments.

Die Casting Machines

The development of improved die casting alloys has been paralleled by equally noteworthy improvements in die design, die casting machines and technique, including higher metal pressures and vacuum casting. The ingenuity of the die designer and the machine builder has stimulated the development of many new products. Electroplated and organic finishes have assisted materially in widening the market for die castings.

One field of development which has challenged metallurgical ability has been the production of better die steels. The demand for new low cost dies, such as sound cast dies with integral cooling channels and permanent high quality cavity surfaces, as well as for longer life steel for brass die casting dies, forecasts still further improvements along the line of die construction. New die casting machines show a tendency to more rigid construction, with higher pressure die closures and vacuum chambers to avoid air entrapment and consequent porosity of castings.

New Alloys and Applications

The 1939 automobile models utilized die castings for new uses such as headlamp bezels and nameplates, and this tendency to further replace stampings by die castings bids fair to continue in the future. Buick's new direction signal employs 13 die castings per unit which are assembled with molded transparent plastic inserts. The modern tough high strength zinc alloys can be die cast in straight sections with thin walls and subsequently formed to the desired shape.

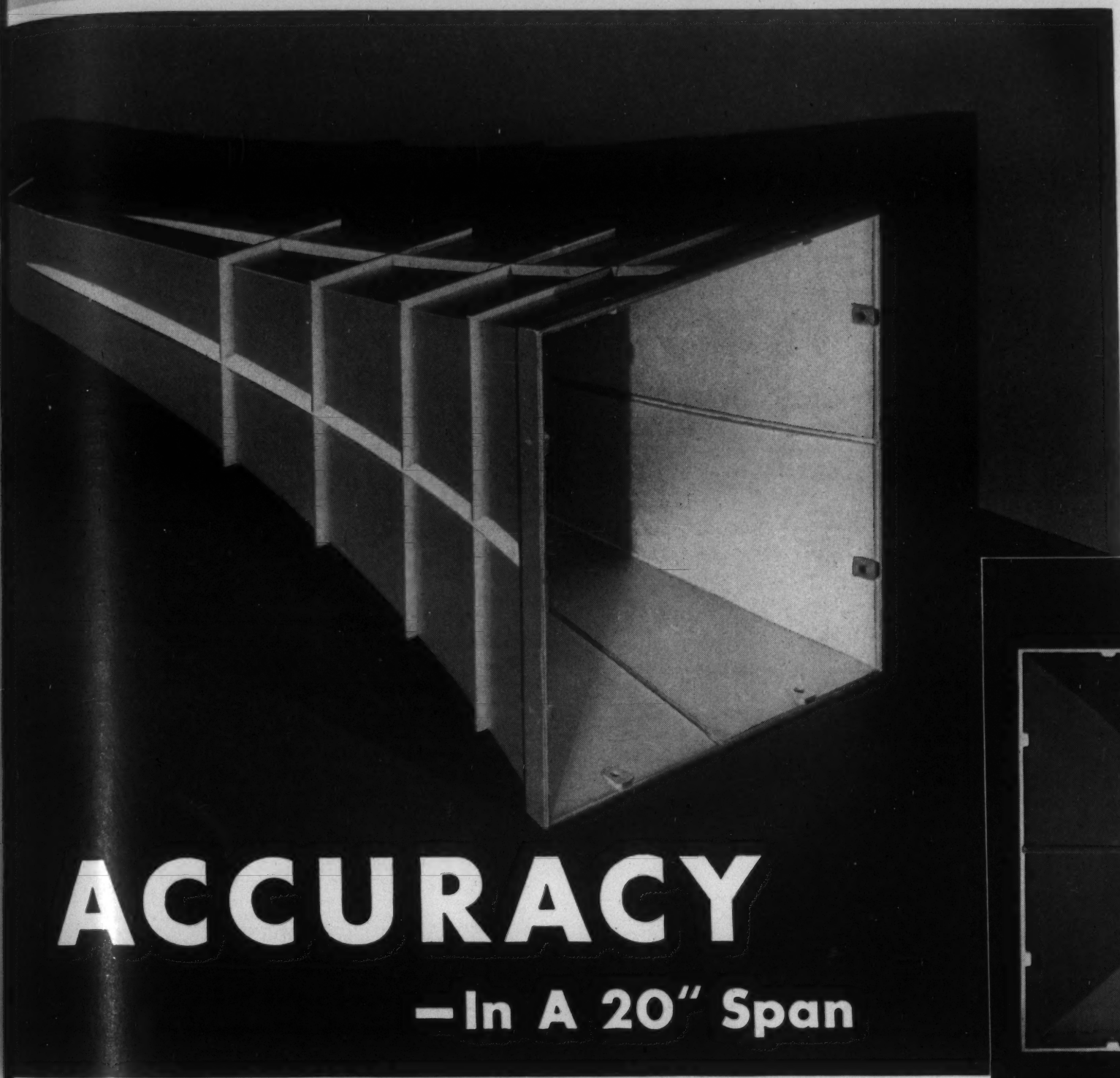
A new aluminum base alloy with 10 per cent magnesium has recently come into some prominence. A recent article in *Aero Digest* reports the use of a single die casting to replace an assembly of several parts including stampings, welded tubing, sand castings and screw machine products, with improved rigidity as well as cost savings.

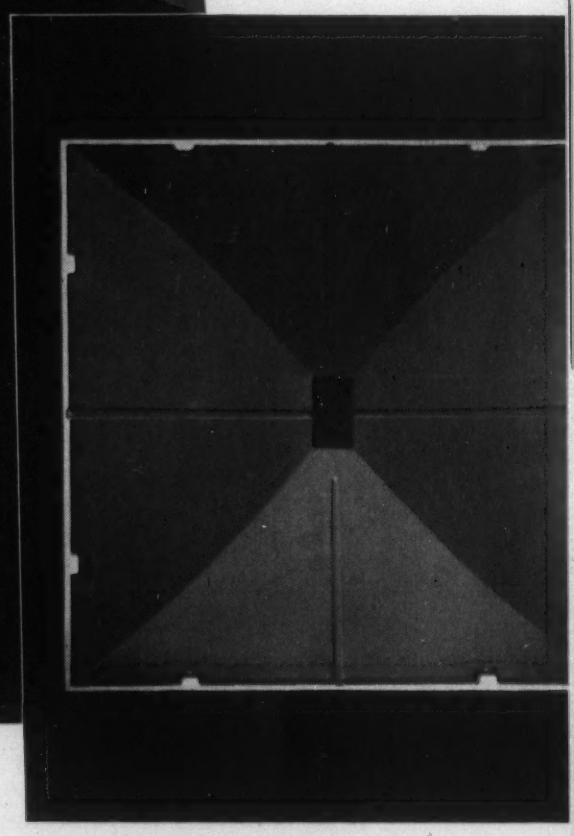
The use of magnesium base alloy die castings may be expected to increase greatly in the future with quantity airplane production, and other uses made possible by the corrosion protection of the new organic coatings. Magnesium alloyed with aluminum and silver offers attractive possibilities. Brass die castings are also being used to some extent in aircraft as well as in motion picture camera and projection assemblies. The prospects for die casting making greater contributions to the economic progress of the future appear excellent.

Some Related Articles in METALS AND ALLOYS

"Modern Zinc-base Die Casting," by W. M. Peirce—June, 1930.
"Plating on Zinc Die Castings," by E. A. Anderson & E. J. Wilhelm—Dec., 1931.
"Press Casting—Its Relation to Die Casting and Permanent Mold Casting," by C. Pack—Feb., 1932.
"Dimensional Changes in Die Casting Alloys," by R. G. Kennedy—May, 1934.
"Metals and Alloys in Aerial Cameras," by E. F. Cone—Feb., 1939.

ZINC ALLOY DIE CASTINGS





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2. RIGIDITY—The acoustical factor also demands that the horn be of sufficient stiffness to maintain its shape in service. With a section thickness of approximately 0.065 in., the die casting easily meets this requirement—although subjected to considerable abuse. (Note the use of strengthening ribs).

3. LOW RESONANCE—The choice of material was extremely important in this application. Properly designed ZINC Alloy Die Castings have a quality of low resonance which makes them adaptable for use in sound carrying equipment.

4. ECONOMY—The only machining required on this part is the drilling of some small holes. And, being of one-piece construction, assembly costs are eliminated.

This application, like most others, has rather unusual requirements. But the ease with which ZINC Alloy Die Castings are solving production problems—in many industries—makes it imperative that you be well versed in this modern metal and method of fabrication. Consult any commercial die caster—or write to this Company for additional information.

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Electroplating

by William Blum

Although 10 years sometimes seems like a long period, very few major developments in any industry come into extensive use within a decade. Consequently any decennial review must include activities that were initiated or anticipated before the beginning of the period, and also those which are now incipient and may or may not mature. In spite of these limitations, I will try to survey briefly, and without specific literature references, the recent developments in the plating field.

Direction of Changes

Even more important than specific improvements, some of which may be sporadic, is the direction of the changes, as this is likely to determine future activities. The electroplating industry has just passed into its third stage. The first stage was represented by the numerous job shops, usually small, and with little opportunity for technical control. The second stage involved large, controlled-production plating units, especially the automatic conveyor installations for the automobile industry that came into use from 1920 to 1930. (The large job shops, better known as "contract platers," belong in this class rather than in the first.) Each of these two classes has a definite place in industry, and they will be supplemented and not superseded by the third class.

The latter may be defined as "preplating," that is, the plating on a very large scale of wires, strips and sheets of metal prior to their fabrication into finished products. The most successful of such operations is the zinc plating of wire at very high current densities, in the "Bethanizing" process. The greater purity and flexibility of the plated zinc coatings make them superior to hot-dipped coatings for certain purposes. Experiments in progress on zinc plating of strips and sheets are encouraging. In these and similar processes, the new methods must be sufficiently better or cheaper than existing procedures to warrant the scrapping of present expensive installations, or else the gradual supplanting of the old process as its equipment becomes obsolete.

Electrolytic Tin Plating

The latter situation partly accounts for the relatively small proportion of tin-plate that is coated electrolytically, even though several successful tin plating processes have been developed and installed. Another problem is to adapt the electro-tin-plate to existing methods of can fabrication, especially the soldering. One advantage of the electroplating process (for both zinc and tin) is that the thickness can be controlled so as to meet any particular requirements more closely and uniformly than can be done conveniently by hot-dipping.

It is not likely that preplating will replace much of the high quality plating of finished articles. The presence of cut, uncoated edges is usually objectionable, but less so with zinc than with tin, nickel, or other metals that do not furnish protection to exposed steel. It is probable that plated sheets will replace hot-dipped sheets, or will lead to new uses of preplated steel.

Electroforming of copper sheets, and of more complicated shapes, including parts of musical instruments, has made substantial progress, not so much through new procedures as through very close control of operating conditions, especially the exclusion of suspended particles from the baths.

The use of heavy deposits, especially of nickel and chromium, for building up worn or under-sized parts is much more extensive in England than in this country, though interest here is now increasing. The difference in practice may be caused in part by the relative costs of labor and material in the two countries.

The use of chromium for wear resistance has shown a steady increase in varied fields of service.

Increase in Research

The last decade has been marked by an increase in researches on electroplating, especially in England and America. These have covered many phases of (a) principles of electrodeposition, (b) new methods of plating, including several new or rare metals, and (c) the specification and testing of deposits (including dropping tests and non-destructive magnetic methods). In certain respects the tests and specifications are most important, because they assist the electroplater to meet definite conditions of service and thus to compete successfully with other materials such as corrosion-resistant alloys, and with plastics, or with other methods of protection, including paint and enamel. Without such ability, the plating industry would soon decrease in importance.

The rapid development of bright nickel and bright zinc plating illustrates the value of intensive research on plating, and also the need for more exhaustive studies on principles of electrodeposition. Until there is a better understanding of the structure of deposits, of its relation to the composition of the baths, and to the polarization and gas-overvoltage, and of the mechanism of addition agents, much of the progress, however real and valuable, rests on a "cook-book" basis. Large industries and technical societies may well encourage and support more fundamental research on plating.

The preceding comments may be summarized in the conviction that the electrodeposition of metals will play a more important part in the future than in the past. Such progress will depend upon cordial and intelligent cooperation of electroplaters, chemists, metallurgists, engineers, and executives. Plating is no longer simply a skilled trade.

Some Related Articles in METALS AND ALLOYS

"Adhesion of Electroplated Coatings," by W. Blum—Feb., 1931.
"Rapid Electrolytic Patina on Copper," by G. L. Craig & C. E. Irion—Feb., 1935.
"Electrodeposition of Iron for Wearing and Bearing Metal," by D. R. Kellogg—Apr., 1935.
"Role of Films in the Electrodeposition of Metals," by W. R. Meyer—May, June, 1936.
"Some Properties of Nickel Electrodeposits," by R. J. McKay—Aug., 1936.
"Bright Nickel Plating," by A. H. Beebe—Oct., 1936.
"Engineering Uses of Heavy Nickel Deposits and Other Plating Advances," by F. P. Peters—Feb., 1939.

Metals and Alloys in the Automotive Industry

by A. L. Boegehold

Improvements in automotive materials will be discussed under the five principal groups: Malleable iron, cast steel, cast iron, wrought steel, and bearing metals.

Malleable Iron

Development has occurred both in the annealing process and in modification of structure and hardness. The principles for drastically reducing annealing time were available more than 10 years ago but only in the last decade have these principles been utilized for shortening annealing cycles from over 100 to 30 hrs. for the regular variety of malleable iron. Irons with higher silicon and lower carbon are being annealed in 15 hrs. or less.

The use of incompletely annealed or reheat-treated malleable iron, covered by the general term "pearlitic malleable iron," has expanded. Rocker arms, camshafts, and pistons, are made from this material. Its use for pistons has been confined to two-cycle Diesel engines. Camshafts made from malleable iron have cams surface hardened by the high frequency induction method, itself a new development.

Cast Steel

Cast steel, which had practically no applications in automobiles 10 years ago, has been developed by one prominent automobile manufacturer. The development of a high carbon alloy cast steel having better casting properties than those previously known has helped its use for crankshafts, brake drums, and pistons. Transmission and rear axle gears have been made by centrifugally casting in a metal mold, a composition similar to that used for forgings.

Cast Iron

New alloys having special properties including high strength and wear resistance have led to special uses for cast iron. Of special alloys for camshafts, one variety contains low silicon and high

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copper controlled so that the point of the cam solidifies white, thus making further treatment of the cams unnecessary. Another alloy for camshafts gives good results when the cam points are hardened by heating with an oxyacetylene flame. Cylinder liners for truck and bus engines, possessing hardness over 500 Brinell after heat treatment, have been adopted. The high hardness has reduced wear to a small fraction of that experienced previously.

Developments in brake drums first led to substitution of higher carbon steel pressed drums which were then displaced by cast iron. High strength cast iron was used until it was found that a good grade of cylinder iron gave satisfactory results. For reducing the cost of cast iron drums a composite drum was developed with steel back and cast iron rim. Two varieties of this type of drum are used. One with the cast iron rim sheathed with and bonded to steel, this rim in turn being riveted to the steel back; the other variety having a steel back inserted in the mold and cast iron flowed around the dove tailed edge uniting the back and rim. Some alloy cast iron is used for crankshafts in other than automobile engines such as in agricultural vehicles.

Steel

The high frequency surface hardening process referred to above under malleable iron is an important recent development. This is used for hardening crankshaft journals, rear axle shaft bearing races, and other similar applications. A steel containing 0.25 per cent chromium and otherwise similar to S.A.E. 1045 steel was developed for use with the surface hardening treatment. Automobile ring gears and pinions have had steady development beginning with substituting S.A.E. 4615 and S.A.E. 4815 steels for S.A.E. 2315, 2515, and other steels, and adoption of box quenching ring gears and pinions without subsequent reheating because of the decided decrease in distortion. With increased knowledge concerning resistance of various alloy carburizing steels to cyclic stress, less expensive steels for rear axle gears including 4100, 3100 and 1300 series steels carburized and box quenched have been used.

A new composition to appear for automobile parts, being used first as a spring steel, was one containing 0.20 to 0.25 per cent molybdenum and possessing a very fine grain size.

The steady increase in the severity of conditions imposed upon exhaust valves has lead to abandonment of the old silchrome composition in favor of austenitic steel containing 22 per cent chromium and 10 per cent nickel for the head welded to a pearlitic steel stem. The latest development is a non-austenitic steel containing 24 per cent chromium, 5 per cent nickel and 3 per cent molybdenum.

For hardening steel without quenching there is the process of simultaneous gas carburizing and nitriding producing an extremely hard surface with greater load carrying capacity. The nitriding process has benefited by introduction of a 4 to 6 per cent chromium-molybdenum steel having resistance to tempering which permits nitriding at usual nitriding temperature without reducing the core hardness below 40 Rockwell C.

For obtaining steel quality, the use of hardenability tests has been consistently increasing and probably will eventually replace specifying steel by grain size. The hardenability test characterized by quenching the end of a 1-in. round specimen is meeting with considerable favor and appears to meet the requirements for a universal hardenability test.

The principal developments in machining are the use of re-sulphurized steel and leaded steel. The re-sulphurizing treatment is applied not only to low carbon screw stocks but also to higher carbon steel like 1045 for use in crankshafts. Lead additions are made also to all varieties of steel. New tool materials are the molybdenum high-speed steels with or without tungsten.

Bearing Metals

The demand for better bearing materials has resulted in steel backed copper-lead bearings, cadmium-silver bearings, cadmium-nickel bearings and the resurrection of high lead-babbitt used many years ago but now bonded to a steel back. Copper-lead bearings and the cadmium bearings are subject to corrosion when lubricating oil attains excessive temperatures so that additional development in bearing metals is necessary and this development is at present going on and the near future will see improved bearing materials to meet the more drastic present day requirements.

Powdered Iron

A development which is quite recent is the manufacture of various parts from powdered iron. With the aid of Swedish powdered iron a number of automobile parts are already being made in production and as soon as cheaper powdered iron is available, which can now be foreseen, the number of automobile parts made by this process will greatly be increased.

Some Related Articles in METALS AND ALLOYS

"*Light Alloys in Motor Vehicle Construction,*" by F. Jardine—Aug., 1932.
"*Story of the Ford Cast Crankshaft,*" by E. F. Cone—Oct., 1935.
"*Lincoln-Zephyr Cast Alloy Piston,*" by E. F. Cone—May, 1936.
"*Ford Centrifugally Cast Steel Gears,*" by E. F. Cone—Oct., 1938.
"*Metals and Alloys Used in Making Rubber Tires,*" by E. F. Cone—July, 1939.

Metals and Alloys in the Electrical Industry

by P. H. Brace

Special alloys have played important parts in electro-technology for many years. Some alloys owe their existence to electrical production methods and these have in turn strongly influenced electrical progress because they enabled new things to be done by electrical means. The electrical industry has frequently found it necessary to take the initiative in the development and initial production of new alloys to serve its particular needs and has been quick to make use of pertinent new things from the laboratories of the metallurgical industries. During the past 10 years the latter have been increasingly alive to the desires of the electrical men.

The General Picture

New combinations of properties are persistently sought, now with emphasis on this or that magnetic characteristic, again with resistivity or thermal expansion in mind. Stability at elevated temperatures, corrosion resistance, mechanical properties at various temperatures as well as availability, cost and ease of manipulation are among the factors which the electro-technologist seeks to adjust and combine in his never-ending efforts to improve the effectiveness of the multitude of electrical devices that surround us.

The interesting nature of some of the more recent alloy developments and the urge for new things has attracted attention from the physicists who have been giving special attention to the fundamental problems of the metallic state. New and useful concepts have been developed concerning the arrangements and interaction of metal atoms and the practical consequences. Educational institutions and metallurgical societies have sought to bring together the pure scientist and the practising metallurgist to the benefit of both.

Magnetic Materials

Now to the metals themselves. Magnetic materials have a dominant place in the electrical world and a surprising variety of new magnetic materials have come into use during the decade. In the permanent magnet field the number has risen from four or five to 20. Outstanding are the Ni-Al-Fe alloys discovered by the Japanese, Mishima, and elaborated by others. Alloys of this type possess much higher magnetic performance than the customary permanent magnet alloys, together with a moderate materials cost.

Other alloys of somewhat similar characteristics and substantially higher performance contain tungsten, titanium and cobalt in addition to nickel, aluminum and iron. Fe-Mo-Co and Cu-Ni-Co alloys with useful magnetic characteristics and a useful degree of workability have been developed and used to some extent. Most remarkable of all is a platinum-cobalt alloy containing approximately 77 per cent Pt which has a coercive force 40 times and a performance factor per unit volume 12 times as great as the 3 per cent chromium magnet steel commonly used for permanent magnets. These properties are so remarkable that this material will undoubtedly find uses despite its high cost.

These new materials have enormously widened the field of action of designers of apparatus employing permanent magnets.

In the Telephone Industry

In the telephone industry there has been much activity on the development and application of low hysteresis-high permeability

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alloys for various special purposes such as cores for loading and filter coils on long telephone lines and for magnetic loading of submarine cables. These alloys are based on Ni-Fe and Ni-Fe-Co with various additions among which are molybdenum, chromium and vanadium which act to control resistivity, permeability and working characteristics. New methods for preparing pure alloys have been developed and important discoveries made as to the effects of heat treatment and cold work on crystal orientation and of the relation of magnetic performance to structure. In the laboratory for single crystals, permeabilities approaching 1.5 million have been reported.

These new materials and processes have had far reaching effects in reducing size and cost and improving performance of equipment for communication by land, sea and air. The spread remaining between the performance attained with commercial alloys and that which could be realized with some of those still in the laboratory warrants the expectation of considerable further progress during the next 10 years.

Electrical Conductors

In the field of electrical conductors considerable progress has been made. The durability of the alloys used in electric heating elements has been increased several fold by detailed metallurgical improvements in the composition and processing of the various Ni-Cr-Fe alloys. New alloys of Fe-Cr-Al have been developed and used commercially at temperatures above the range of the conventional Ni-Cr materials. An alloy of iron and nickel, approximately 50-50, has been found very satisfactory for heating elements in hydrogen and hydrogen-nitrogen atmospheres for temperatures up to 1250 deg. C. and is in use in several large industrial furnaces. Ceramic coatings have been applied to tungsten and Mo-W alloy rods to provide resistor elements that may be operated in air up to 1500 deg. C. The future may bring some important applications of heating elements of this type.

Standard resistors play a very important part in electrical measuring instruments. The conventional material is "Manganin," a Cu-Ni-Mn alloy. Considerable effort has gone toward improving this class of material with respect to temperature coefficient and stability. One distinctly new material has been developed at the U. S. Bureau of Standards. This is a Au-Cr alloy containing approximately 4 per cent Cr and having a very low temperature coefficient of resistivity over a relatively wide range of temperature together with remarkable stability. It is coming into use for high-grade precision resistors.

High-strength high-conductivity copper-base alloys of the age-hardening type have been developed and used to solve various electro-mechanical problems such as those presented by large high-speed slip rings and spot-welding electrodes for example, as well as other electro-mechanical parts requiring material having electrical and thermal conductivities near to that of copper, the strength of structural steel and the ability to retain relatively high physical properties under prolonged heating at temperatures that would take all the starch out of work-hardened copper. Conductivities of the order of 85 per cent of that of pure copper together with tensile strengths near 75,000 lb. per sq. in. are now commercially available in certain Cu-Cr-Ag alloys. Higher hardness at the expense of somewhat lowered conductivity are provided by Cu-Co-Fe and Cu-Be-Co alloys. All these are heat-treatable alloys in which use is made of age-hardening phenomena to obtain the desired favorable conductivity-strength ratios.

Recognition of the effects of small amounts of silver in retarding the softening of cold worked copper has led to the use of cold-worked argentiferous copper ("Lake Copper") in commutators and some other places where operating temperatures may exceed those permissible with ordinary cold-worked copper.

Springs

In electrical apparatus, springs are often required to carry current and perform mechanical duties as well. Age hardened Cu-Be and Cu-Be-Ni alloys have come into use in some of the more exacting situations partly because of reasonably good electrical conductivity, but principally because excellent fatigue properties can be obtained.

Electrical contact materials have been the object of intensive study particularly by the telephone industry, and special alloys of silver, gold, palladium, platinum and iridium have been developed to meet special situations. Much of this work has had

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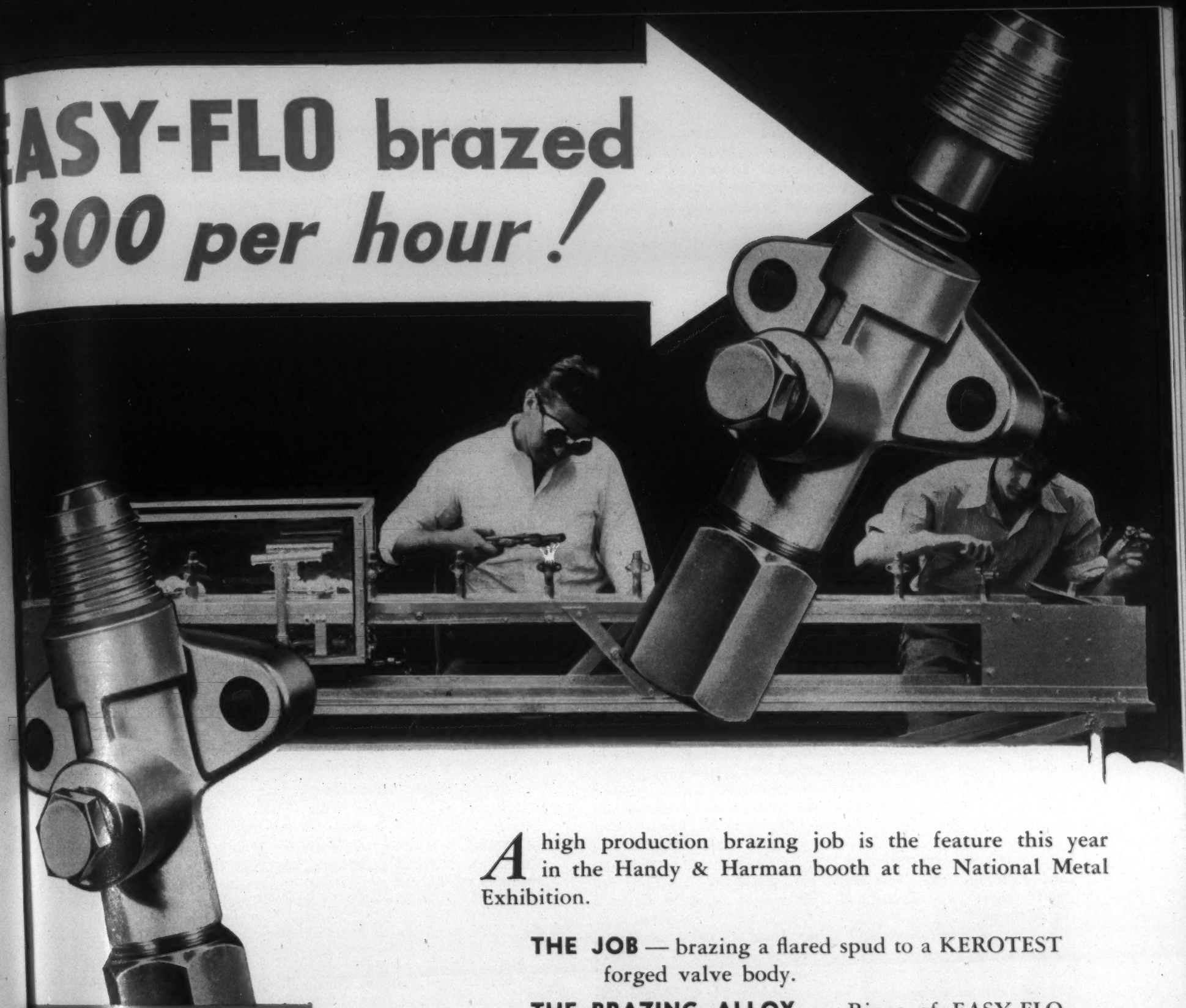

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to do with the careful adjustment of the composition of the contact material to the service conditions—there is no "best" contact material. Silver-graphite mixtures arrived at by powder methods have been quite important in circuit-breakers and have much to do with the success of the fuseless control panels for controlling and protecting the lighting circuits in homes and buildings.

Temperature Responsive Elements

The widening use of temperature-responsive elements in electrical control apparatus has led to the development of a great variety of thermostatic bimetals whose component alloys have been developed with an eye not only to mechanical properties and expansion characteristics, but also electrical performance. Special requirements as to resistivity and temperature coefficient as well as mechanical response to temperature changes have been met and the upper limit of operating temperatures raised. Some 20 or more distinct combinations are now in use, most of which have come out within the past 10 years. Most of the new component alloys are based on iron, nickel, cobalt and chromium. An exception is a high-manganese copper alloy said to have higher expansivity and better hot strength than brass.

Base-metal thermocouples have assumed a very important place in the control of industrial heating operations. Detail improvements of existing alloys and standardization have improved the picture here.

Vacuum Devices and Electrotechnology

Vacuum devices have played a very important part in recent electrotechnology. Getting electricity into the vacuum usually involves the attachment of metal to glass and is a perennial problem which has become increasingly difficult as the size of industrial electronic devices has increased. Recently new alloys based on cobalt, nickel and iron have been developed which can be sealed directly to modern low-expansion glasses to produce vacuum-tight lead-in structures. Alloys of this type have been applied with success in a variety of cases ranging from that of the all-metal radio tube to power rectifiers and the ignitron tubes used for timing the power impulses in "spot" and "shot" welding operations now so extensively used in joining the parts of all sorts of things from "five and dime" gimcracks to streamlined stainless steel railroad cars and light weight structural elements for skyliners.

In power transformers and other large electrical apparatus, internal electrical connections must be so made as to withstand the temperatures and stresses that may be set up by overload and short-circuit conditions. To meet this need, Cu-P and Cu-Ag-P brazing alloys have been developed. These have melting points intermediate between those of Pb-Sn solders and conventional brazing alloys and are very convenient for producing high strength joints between copper parts particularly when the jointing must be done in a confined space as in some assembly operations.

As to the Future

Perhaps a review should be followed by a forward look—we believe we now know, even unto the uttermost isotope, almost everything we will ever have upon which to build compositions of matter. However, new changes will be rung while of the old we will still be learning surprising things. If we estimate the number of unexplored compositions, consider the new tools of investigation, theoretical as well as experimental, now at hand and note the increasing tendency to specialization of materials for specific use, we may well feel confident that the next decade will see progress comparable to that of the last,, perhaps by the summation of numerous small steps as compared with the broad jumps of the past 30 years but nevertheless progress which will be apparent in our everyday lives.

Some Related Articles in METALS AND ALLOYS

"A New Solder for Electrical Apparatus," by J. Silberstein—Aug., 1930.

"Magnetic Properties of Fe-Co-W Alloys," by B. A. Rogers—May, 1933.

"Some Metallurgical Aspects of the Radio Tube Industry," by S. Umbreit—Oct., 1935.

"Development of Power Cables," by W. H. Bassett, Jr.—July, 1937.

"Steels for Turbine Rotor Forgings," by N. L. Mochel—Oct., 1937.

"Carbonized Nickel for Radio Tubes," by T. H. Briggs—Nov., 1938.

"Effect of Very Small Additions to Transformer Steel," by W. S. Messkin & J. M. Margolin—Jan., 1939.

Electric Melting of Non-Ferrous Metals and Alloys

by G. H. Clamer

The depression, extending over practically the entire period of the past decade, 1930-1939, has presented industry with many new problems. The non-ferrous industry has not escaped these.

Except at the beginning, during the prior decade (1920-1929), aptly characterized as the "golden glow," industry was concerned mainly with problems of maximum production. During that period many electric furnaces were installed. Many fuel furnaces were replaced under conditions which were such that an electric furnace was not justified. In some cases electric furnaces of a type not best suited for the particular requirements were installed. In other cases the then existing tonnage melting requirements were sufficient to justify the installation of an electric furnace, but during the depression this no longer held true.

The Standby Charge

The experience during the depression led to exhaustive study of melting technique and equipment. Maximum economy was the keynote stressed by management. In seeking maximum economy melting costs were studied. The so-called standby charge of the power companies called for complete investigation. This was one of the many items of overhead to which the managerial finger pointed. During the period of the "golden glow," with its high rate of production and its consequent large divisor, this item attracted little if any attention. As furnace operating hours were reduced, and particularly during periods of complete shutdown, the item of standby stood out in bold relief.

In the wrought brass industry, due to difference in operating conditions as compared with those prevailing in the brass foundry, but mainly because of the more favorable relationship of standby to actual power used, the problem of standby was not so serious. There have been no reports, to the writer's knowledge, that any of the electric melting equipment in the wrought brass industry has been discarded in favor of fuel melting equipment.

Fuel Furnaces in Small Brass Foundries

Many electric furnaces in small brass foundries have been replaced by fuel furnaces during the past decade, mainly because of the continuing standby charge during shutdown or low production periods. In some cases power companies voluntarily during stated short periods eliminated the standby charge. This action no doubt was responsible for the retention of a number of electric furnace installations that would otherwise have been discarded. In the foundries normally having a large production the conditions were more favorable and approximated the conditions prevailing in the brass mills. No large installations of electric furnaces, so far as the writer knows, have been abandoned.

During the period of the "golden glow" little if any attention was paid to the matter of power factor, the emphasis always being on tonnage production per day. Improvement in power factor has been accomplished through better designing of electric furnaces, but more particularly through the installation of power factor corrective equipment such as static condensers or synchronous motors. Suitable static condensers were only beginning to be used 10 years ago. Static condensers are today in quite extensive use for this purpose.

Larger Capacity Furnaces

Another trend during the past decade has been toward furnaces of larger capacity. This is particularly true in the wrought brass industry. This trend has followed the development of high speed metal working equipment such as, for example, improved strip mills, larger extrusion presses, tube making equipment, etc. Melting of zinc and copper in some cases has called for large melting units, viz, capacity of 10 to 20 tons. In these fields the electric furnace has justified its use, not only from the standpoint of economy, but improvement in the quality of product. No demand for larger furnaces in the brass foundries has arisen. In the foundries producing castings requiring large single batches of metal at irregular intervals, fuel furnaces are best suited.

The use of the electric furnace has extended in the field of melting precious metals, thus proving its merit in that field.

In Europe many furnaces for melting aluminum have been installed. A few of these have been of the resistance type—all the others of the submerged molten resistor induction type. Ingenious devices for cleaning the resistor channels of adhering skull have been devised. This in the past has been one of the serious objections to the induction type. There have also been a number of high frequency coreless induction furnaces installed for this purpose, as well as for melting nickel and nickel-base alloys.

Advantages of Electric Melting

To determine if electric melting may be advantageously used, the following should have most careful consideration:

(1) Weekly quantity to be melted.
(2) Probability that production will be maintained at nearly the estimated rate.
(3) Power demand charge for the minimum hourly output for which the equipment may be used.
(4) If penalty may be imposed due to low power factor.
(5) Original cost of equipment and installation thereof, including all appurtenances.
(6) Probable operating cost including repairs, refractory, labor, metal losses, etc.
(7) The possibility of operating two or three shifts per day, thus reducing space requirements to a minimum.
(8) Can quality of product be improved or end cost of finished product reduced?
(9) Advantages resulting due to improved working conditions.

In the wrought brass industry answers to the above questions have been such as to warrant the installation of additional units to existing installations and the few remaining fuel furnaces have been almost completely replaced by electric furnaces. Electric furnaces are now melting practically 100 per cent of the metal melted in that industry.

Some Related Articles in METALS AND ALLOYS

"Pouring Practice for Avoidance of Defects in Aluminum Ingots for Rolling," by G. L. Craig—Oct., 1931.

"Monolithic Linings for Induction Furnaces Melting Non-Ferrous Metals," by P. S. Kingsley—May, 1933.

"Electric Furnace Refractories in the Brass Foundry," by H. M. St. John—Dec., 1933.

"Manufacture of Oxygen-free High Conductivity Copper," by E. F. Cone—Feb., 1937.

"The Hydride Process," by P. P. Alexander—Sept., 1937; Feb., July, Oct., 1938.

"Melting of Wrought Phosphor Bronze," by L. Kroll, F. E. Ball & E. A. Anderson—Nov., 1937.

"Manufacture of Cast Trunnion Bearing Metal," by J. A. Duma—May, June, 1938.

Aluminum and Magnesium

by Junius D. Edwards

The last 10 years have been a period of progress in the aluminum industry and research has played an important part in this advance. Even when general business activity was low, research on aluminum was being pushed vigorously. These few paragraphs do not permit much detail, but the broad trend shows countless new applications of aluminum made possible by research.

Aluminum

The fundamental investigations of the previous decade have borne fruit in the new aluminum alloys developed and put into production during the past 10 years. The slogan, "Nature made aluminum light, but research made it strong," aptly characterizes this development. New aluminum alloys of greater strength, new aluminum alloys of superior serviceability in salt water and other environments, new aluminum alloys for special services, all have increased the usefulness of aluminum and have been an important factor in its steadily increasing industrial application.

The most striking examples of these new uses are the structural applications. Stream-lined aluminum trains of high speed are now almost a commonplace, although the first one was a great novelty.

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Previous experience with aluminum in railway car construction helped make the first stream-lined aluminum train an instant success. Aluminum has proven itself indispensable in a world where speed and safety are prime elements in transportation. The transport airplane of today has 80 to 90 per cent of its structural weight in aluminum alloy.

With aluminum alloys a standard structural material for trains, buses and airplanes, aluminum is now entering the field of marine transportation, and this should be one of the applications in which important advances will be made during the next decade. The increasing uses of aluminum in architectural applications and in the chemical and food-processing industries must be at least mentioned.

The many structural applications of aluminum alloys have had a firm foundation laid by Aluminum Research Laboratories in their investigation of the fundamental problems involved in building strong, but light, structural members. The engineer now has available in its second edition, a Structural Aluminum Handbook to guide him in matters of engineering design.

In making aluminum more useful, the field of finishing has not been overlooked. A striking development has been that of anodic coating, so well represented by the "Alumilite" and "Alzak" processes. All types of finishing processes such as painting, plating, and anodic oxidation have received the benefit of continued research and have done their bit to make aluminum more useful, both by way of decoration and by increased protection.

Magnesium

The last 10 years have seen the producers and fabricators of magnesium in an active search for markets. The use of magnesium has been stimulated by price reductions which have brought its price per cubic foot down to that of aluminum. Research has been pushed as well, and the increased consumption of magnesium is largely due to technological advances in the fabrication of the metal. These are of a broad character and include the development of magnesium alloys with improved mechanical properties and stability. Economies have been made in such fabricating processes as extrusion, sand and die casting, and forging, including the ability to make magnesium alloy products of large size and complicated design by these processes. For many services magnesium must be protected, and research in this field has led to better coating and painting methods for protecting magnesium. The magnesium consumption curve points sharply upwards.

Some Related Articles in METALS AND ALLOYS

"Light Alloys," by Zay Jeffries—Dec., 1929.
"Light Alloys in Motor Vehicle Construction," by F. Jardine—Aug., 1932.
"Properties of Wrought Aluminum Alloys at Elevated Temperatures," by F. M. Howell & D. A. Paul—Oct., 1935.
"Fifty Years of Aluminum Alloy Development," by E. H. Dix, Jr., & J. J. Bowman—Feb., 1936.
"Aluminum in Marine Construction," by H. D. McKinnon—July, 1938.
"The Properties of High-Purity Aluminum," by C. S. Taylor et al—Aug., 1938.
"Aluminum Alloys in the Railroad Industry," by A. H. Woolen—Jan., 1939.

Alloy Steels

by H. J. French

Significant changes have occurred in the alloy steel industry during the past 10 years, but only a few of the broadest trends can be mentioned, due to space restrictions.

The automobile industry still is the largest single consumer of wrought alloy steels, but this industry's proportion of the total consumed in the United States has decreased during the past eight or 10 years. This does not signify a loss in markets, but that alloy steels have assumed a more important role in other industries. (Annual Statistical Report, 1938, American Iron & Steel Institute.)

The distribution, by types of product, likewise has changed. The proportion of hot and cold finished bars, while still accounting for more than two-thirds of the total alloy steel produced, has decreased, while the percentage in sheets and other flat rolled products has increased.

The broadening of the markets for alloy steels is, no doubt, due to a variety of favorable factors, although probably they are all allied with the fact that alloy steels, as a class, can serve economically to defeat the destructive forces encountered in industrial machinery and equipment. In addition to providing higher strength per unit of weight (or bulk) without impairment of safety, alloy steels permit improvement in resistance to fatigue, corrosion, wear, the weakening effects of elevated temperatures and the embrittling effects of sub-atmospheric temperatures.

Stainless Steels

Outstanding in the record of progress of the last 10 years has been the commercial development of the stainless steels containing chromium or chromium and nickel, with or without additions of other elements. Volume has taken a marked upward trend, as shown by the fact that in 1929 ingot production of all varieties was about 48,000 net tons, while in 1937 it exceeded 150,000 net tons. At the present time, over 40 varieties are recognized in the American Iron and Steel Institute *Steel Products Manual* covering stainless steel type numbers and composition ranges.

The uses of the stainless steels in architecture and industrial equipment, where advantage is taken of their resistance to corrosion and staining, have been supplemented by their application in transportation units where high strength and satisfactory fabricating qualities have been added requirements.

The stainless steels have disproved the old concept that ferrous metals were primarily of value for their strength and hardness, while the non-ferrous metals provided resistance to corrosion.

Process Control

Process control, which, in its broadest sense, includes everything that contributes to the consistent procurement of desired performance qualities, is fundamentally a part of steel making, but it is especially valuable with alloy steels.

Improvements in technique involving co-ordination of many steps from scrap selection to slag control, methods of deoxidation, and conditions of working have been responsible, in a large part, for improved economy in the applications of alloy steels in certain markets. A part of this picture is reflected in what is commonly termed "grain size control," whereby steels of a given type can now be made to show consistently uniform performance qualities and response to treatment.

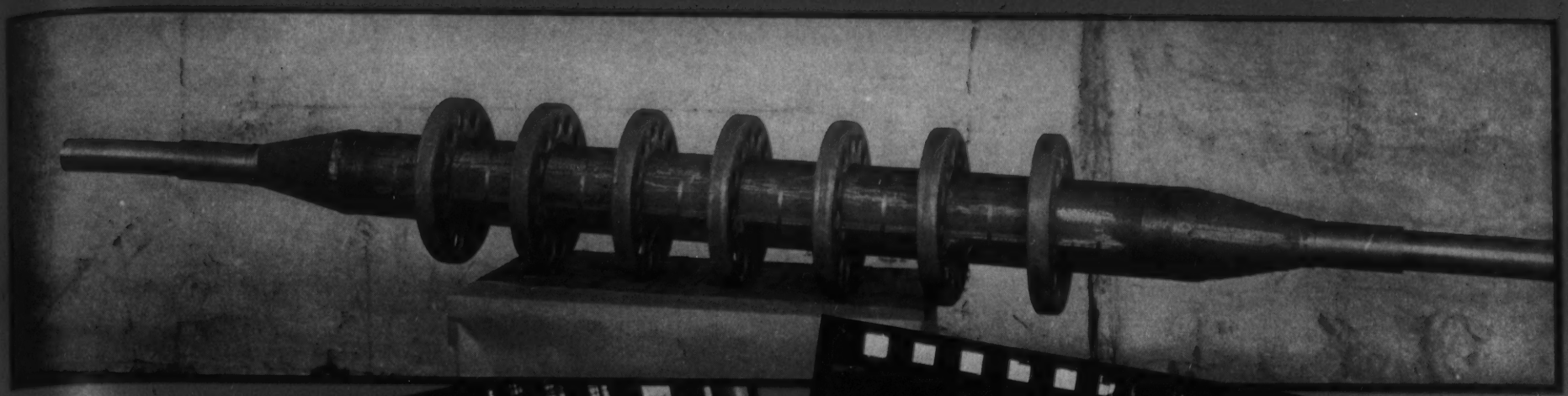
The improvements resulting from process control have made possible readjustments downward in alloy contents for many heat-treated parts of small or moderate section and substantial economies have resulted. For example, with grain size control, certain steels, when formed into gears, show low distortion on hardening, and this can be kept within close tolerances in production, reducing scrap, remedial operations, etc. The superior toughness of fine-grained carburizing steels and their resistance to grain coarsening at carburizing temperatures permit direct quenching, often with economy and superior performance.

Many problems remain concerning process control. One of these, of current metallurgical interest, relates to two different practices now in use in automobile construction. In the one, steels are used which, while fine grained, will harden to a high degree throughout the entire section. Penetration of hardening is desired prior to tempering. In the other, fine grained steels with small alloy additions and often increased carbon contents, which are shallow hardening, are employed. High surface hardness but low penetration is the rule. Only time can reveal which of these practices provides the best performance or whether both may be used.

Low Alloy, Strong, Corrosion-Resisting Steels

An important development of recent years comprises a group of alloy steels especially suited for fabricated structures, for which combinations of the following requirements have to be met: (1) Moderate cost, (2) improved strength properties in the rolled, normalized or annealed conditions, (3) ease of fabrication, including cold forming and welding, and (4) improved resistance to corrosion.

Practically all of the current commercial types contain less than 0.25 per cent carbon and under 1 per cent manganese, when produced in flat products or structural shapes. All of these steels contain copper between about 0.4 and 1.5 per cent. A majority of the group, at present, are of the copper-nickel alloy



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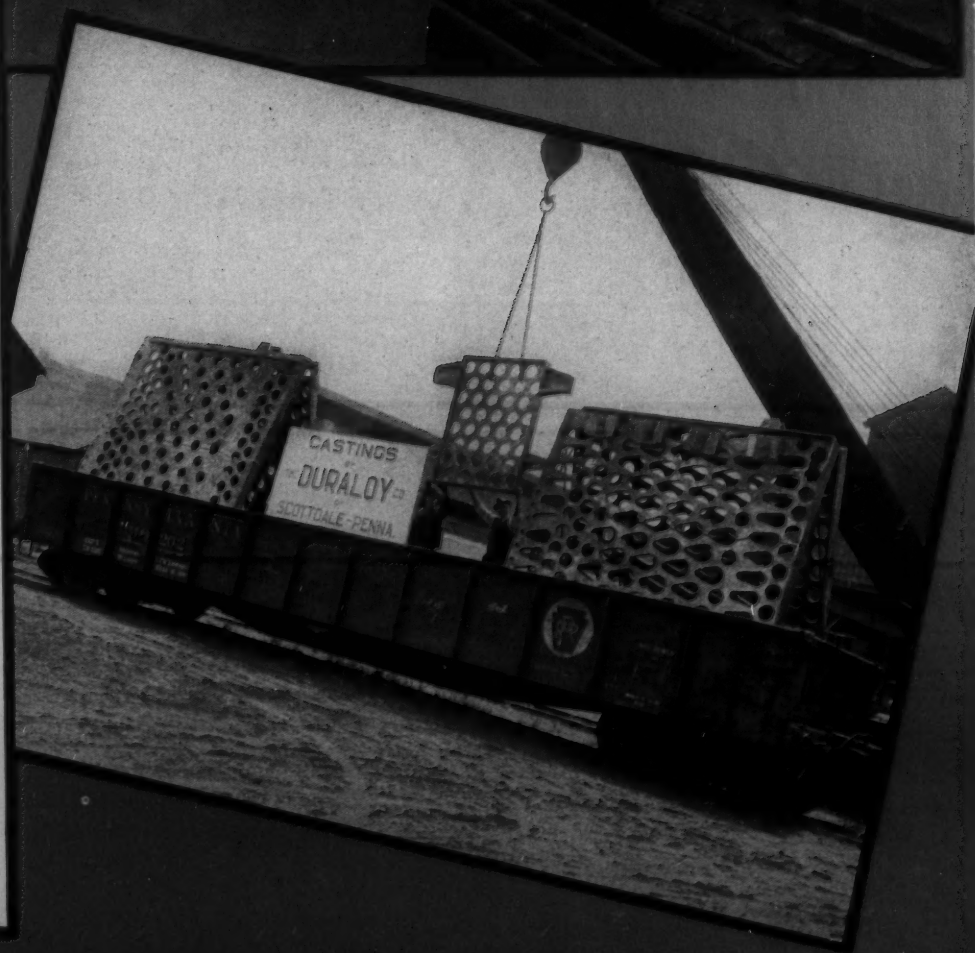

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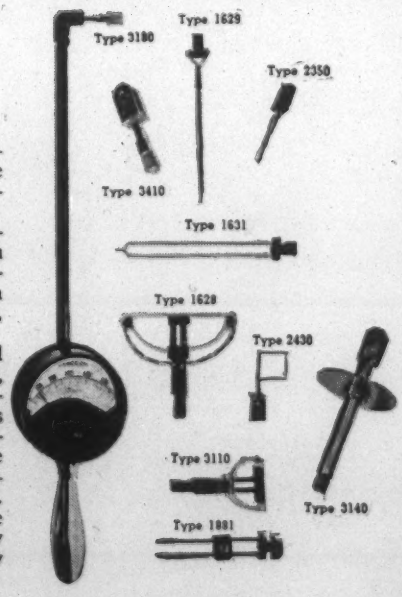

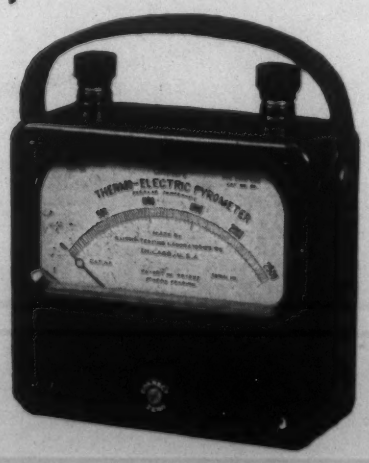

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type, with or without reinforcement from other elements such as chromium, molybdenum, or increased phosphorus content. Silicon-chromium-copper steels are represented in the current commercial varieties, as are specially processed steels containing copper and increased phosphorus.

Minimum yield points of 65,000 lbs. per sq. in. can be secured in some of these steels in certain size ranges, but usually 50,000 lbs. is the minimum specified, since the elastic moduli of all ferritic steels is the same and higher properties do not necessarily bring proportional advantages to the engineer.

Since their commercial inception about five years ago, such steels have been produced in increasing amounts and their applications have become diversified. Their value, as a group, is chiefly associated with their "high strength properties" at quite low carbon contents, which permits ease of cold forming and welding, but combined with this is improved corrosion resistance in the atmosphere and certain other environments.

Free Machining

Alloy steels made especially to provide improved machining qualities have become more widely used. This applies both to the constructional steels and the stainless steels. Sulphur, as the addition agent to provide free machining, has been followed by selenium (or tellurium) and lead. Any one practice may not provide attractive improvements under all conditions, but the free machining alloy steels have become firmly established and have contributed definitely to an extension of markets.

Age hardening effects, long utilized in the non-ferrous metals, have become useful only recently in the steels. The low alloy, corrosion-resisting steels containing more than about 0.75 per cent copper, and Nitralloy N, containing both aluminum and nickel in suitable proportions, respond to age hardening treatments. Use has been made of age hardened copper-nickel steels (A. E. Gibson: "Nickel-Copper High Strength Steels Meet Specifications of Welded Construction," *Steel*, January 25, 1937, p. 34) in welded structures which, because of size and shape, could not be quenched and tempered without difficulty.

Welding, Selective Treatment, and Surfacing

Marked advances have been made in the welding art and in the development of methods of flame hardening, hardening after induction heating, and in the surfacing of metals for resistance to wear and erosion. These developments have helped to provide alloy steel parts better suited to meet modern requirements, and they have been reflected in the markets for alloy steels.

Welded alloy steels are found in a variety of industries, including automotive, railroad transportation, power, shipbuilding, oil, etc. Welding has played a part in the effective utilization of the special properties of alloy steels in pressure vessels for high temperature service or for low temperature dewaxing of lubricating oils, while hard surfacing applied to alloy steels has provided improved performance in parts of equipment for oil well drilling, mining, and excavating.

Conclusion

The selected items represent only some of the major trends. Our knowledge, both general and specific, of the effects of alloys in steels has improved, so that today we are in a better position to meet the advancing requirements of industry. Better steels are available for resisting corrosion, fatigue, creep at high temperatures, embrittlement at low temperatures, and wear. Much more remains ahead, but the record of the past 10 years is one of measurable progress in our efforts to gain a better mastery of the metallurgy of the alloy steels.

Some Related Articles in METALS AND ALLOYS

"Production and Heat Treatment of Alloy Steels," by R. A. Bull—Sept., 1931.
"Causes and Avoidance of Tool Steel Failures," by W. H. Willis—Sept., 1931.
"Special Austenitic Steels for Severe Corrosion Resistance," by J. A. Parsons, Jr. & E. Ryder—Mar., 1932.
"Titanium Improves Pearlitic Manganese Steel," by G. F. Comstock—May, 1937.
"Microstructures of Mo-Max and 18-4-1," by R. G. Kennedy, Jr.—Oct., 1937.
"Low-Temperature Impact Properties of Some SAE Steels," by A. J. Herzig & R. M. Parke—Apr., 1938.
"Stainless Forging Metals," by W. Naujoks—May, 1939.
"Trends in Alloy and Electric Steel Output," by E. F. Cone—Aug., 1939.

Steel Castings

by John Howe Hall

During the past 10 years, the industry has perfected technique for casting the heat and corrosion-resisting chromium and nickel-chromium alloy steels, especially the 18 chromium-8 nickel, 25 chromium-12 nickel, and 15 chromium-35 nickel grades. By suitable modifications in the silicon and manganese content, which usually run higher than in the corresponding rolled products, the sluggishness of these metals, which at first made the problem of casting them extremely difficult, has been largely counteracted, so that satisfactory castings are produced.

In many shops, the problem of continuously securing satisfactorily low carbon content in the alloy steels, and at the same time remelting the heads, gates and risers, has been solved by the use of the Ajax-Northrup type high frequency melting furnace.

Aluminum Embrittlement

For a number of years, so-called "aluminum embrittlement," especially in acid electric cast steel, had plagued the maker of small steel castings. The trouble consisted in low ductility in a certain proportion of the heats produced. Lillequist, Sims and Dahle have carried on research work looking to the cure of this difficulty, and the two latter have now perfected a method by which the trouble appears to be obviated, while the use of aluminum to promote soundness in the castings is continued. Corroborative evidence has been contributed by Gagnebin. This is a most valuable contribution to the art of steel casting manufacture.

The production of heat-treated low-alloy cast steels has been brought to a high state of perfection, and these grades of steel are recognized in standard specifications of the American Society for Testing Materials, No. A 148-36. By a combination of judiciously chosen alloy content, and suitable heat treatment, cast products of very excellent physical properties are regularly produced, of a grade that would formerly have been supposed impossible of attainment. Oil and water quenching of steel castings, once thought impracticable, is now a regularly recognized procedure in well equipped foundries.

Differentially hardened steel castings, with hard areas to resist wear and strong, tough body portions, are extensively produced to meet severe wear conditions coupled with heavy stresses. Flame hardening with oxy-acetylene or other gas torches fits excellently into this phase of casting manufacture.

Castings in Welded Parts

The use of steel castings as constituent parts of welded assemblies has made continuous progress. This year, the American Society for Testing Materials has recognized the availability of weldable grades of steel castings by the adoption of tentative specifications for carbon steel castings of weldable grade for miscellaneous industrial uses (A215-39T), and two tentative specifications for carbon and alloy steel castings of weldable grade for service at temperatures up to 850 deg. F. and from 750 to 1100 deg. F. respectively (A216-39T and A217-39T).

With the improvement of welding technique and the rapidly expanding utilization of radiography to test the soundness of castings and of welds, repair of castings by welding has been recognized as a legitimate part of the manufacturing process, and countless castings are now salvaged by proper welding repair, that customers would have refused to accept not so many years ago.

At the same time, great progress has been made in eliminating unsoundness, by studies with radiographic methods, so that defects formerly unsuspected or ignored are now commonly avoided by the examination of pilot castings made to test foundry methods, before undertaking quantity production. In the case of very important castings, such as valves and fittings in power houses, oil distilling plants, etc., all castings produced are sometimes subjected to radiographic examination.

Production of very large integral castings for railroad and industrial use has made steady progress, and castings are now

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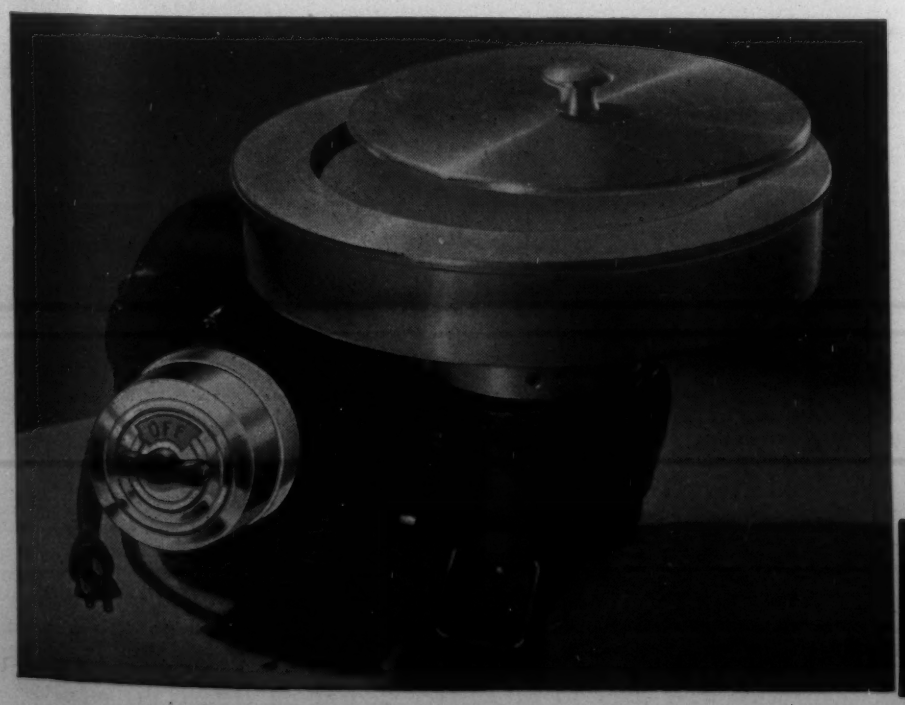

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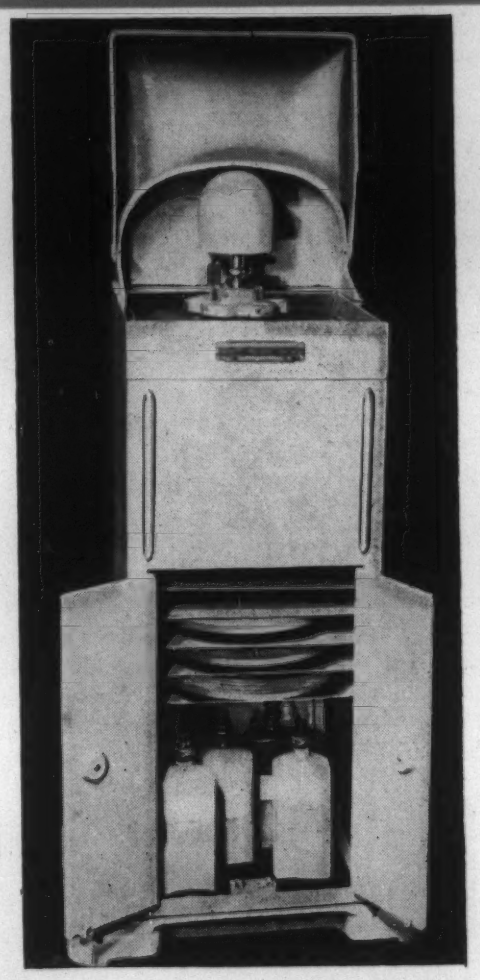

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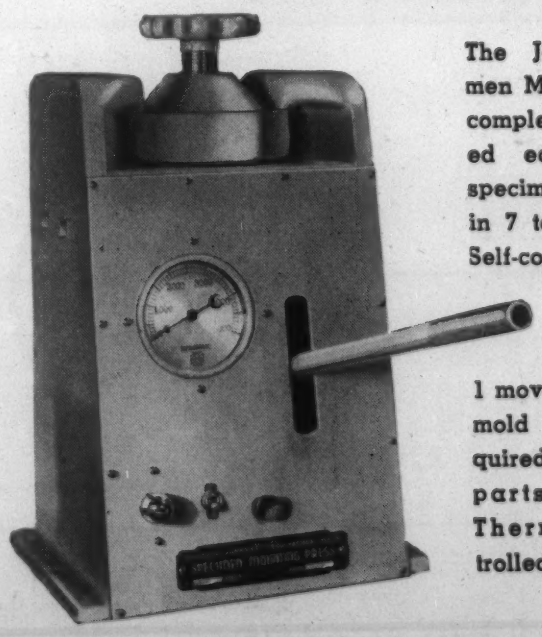

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being marketed regularly to replace what were formerly fabricated assemblies. The ability to furnish long integral structural members whose main portions vary continuously in thickness from ends to middle, thus putting the heaviest portions where the greatest stresses occur, with a considerable saving in weight, is a contributing factor in sending this business to a foundry. The intricacy and completeness of many of the modern one-piece railway castings, such as car trucks, integral tender frames, locomotive beds, etc., is almost beyond belief, and would have been voted the dream of impractical visionaries, not so many years ago.

Centrifugal casting of tubular parts of varying size and length, and of gear blanks and similar shapes, has been developed on a commercial scale in several shops. Castings of this type are made in carbon, low-alloy and high-alloy steels, with a considerable saving in heads and gates, and a marked improvement in soundness.

Molding Processes

Two molding processes have been introduced from abroad, both of which have attracted considerable attention. The details of one, the Fisher method, have been jealously guarded as a trade secret, known only to those using the process. The other, the invention of Jean Baptiste Durand, and known as the Randupson process, has been described freely by the American representatives of the owners of the patents, and has been the subject of extensive discussion in foundry circles. Briefly, the method consists in using cement and water as the sole binders for the sand or other refractories, and is said to secure many of the advantages of dry sand methods, at a cost approximating that of green sand molding. The process is applied to steel, iron and non-ferrous work, and it is claimed that by its use castings are produced superior in accuracy and appearance to what are secured by other methods.

Some Related Articles in METALS AND ALLOYS

"Sand Control in the Steel Foundry," by H. D. Phillips—Oct., 1930.
"Electric Steel for Castings," by H. D. Phillips—Oct., 1932.
"Some Metallurgical Aspects of the Present Production of Steel and other Ferrous Castings," by R. A. Bull—Jan., 1934.
"Story of the Ford Cast Crankshaft," by E. F. Cone—Oct., 1935.
"Recent Developments Affecting the Testing Society's Specifications for Steel Castings," by R. A. Bull—Jan., Feb., Mar., 1936.
"Cupola Hot Metal Duplexing for the Electric Steel Foundry," by H. B. Kinnear & H. W. Gillett.—Dec., 1936.
"Low Alloy Steel Castings," by A. Finlayson—Sept., 1937.

Notch Effect in Testing Steels

by S. L. Hoyt

The question of the effects of a notch on the behavior of stress-carrying members has two aspects—one dealing with parts subjected to fatiguing stresses and the other with parts subjected to single overloads which either break the part at the notch or cause it to deform.

During the past 10 years considerable work has been done in both fields, so that now it should be possible to begin to crystallize our thinking in each. In particular it has become clear that no direct correlation exists between these two types of notched bar tests. Steel with good tensile properties may be either tough or brittle in a single-blow notched-bar impact test while the behavior in notch fatigue may be good or bad (though with less variation) whether the single blow notched bar test results are good or bad.

It has been known for years that the surface condition and contour have important effects in reducing the fatigue strength, but it is of only recent date that such observations have stimulated quantitative investigations of the effects.

Better Understanding of Notch Effects

It may still be too early for appraisal, but in the past 10 years there has come a material improvement in our understanding of notch effects and the ability of steels to retain ductile behavior when notched. Metal being fatigued (a progressive cleavage phenomenon) is being plastically deformed and work hardened. In contrast to the common types of plastic deformation, which have been so extensively studied, in fatigue the metal is

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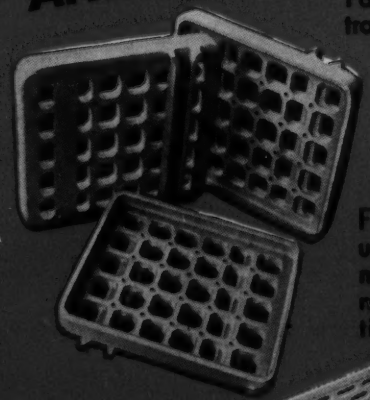

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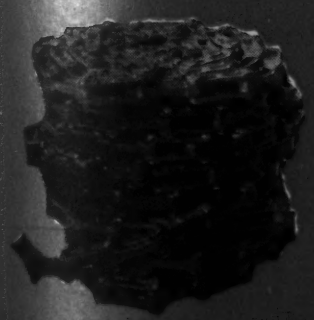

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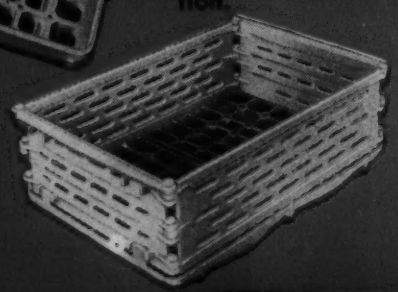

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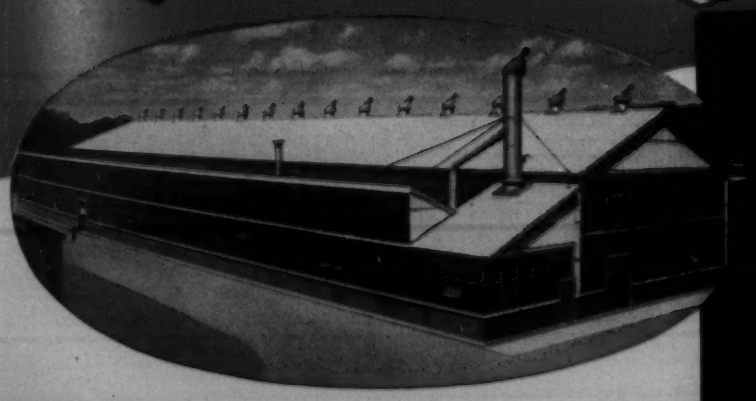

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stretched and compressed (for reversed cycles) with a large total or summated deformation but with only minor changes in shape.

The behavior is particularly important when a notch is present because the metal at the root of the notch, and to some depth below and along the sides of the notch, is worked backwards and forwards by a kneading action. Experimental determination of deformability, which controls the size of stress peaks developed, requires new technique and to this end a micro-extensometer has been developed (E. Lehr, Metallwirtschaft, Vol. 18, July 7, 1939, p. 595) with which a magnification of 100,000 times or even 1,000,000 times can be secured.

Considerable work has been done to discover what relationships there may be between the results of the tensile test and notch fatigue behavior. Comparing the tensile strength with the fatigue strength, the fatigue strength to tensile strength ratio usually comes within the limits 0.4 to 0.6. While this can hardly be considered sufficiently constant for design purposes, the establishment of an approximate ratio is useful in selecting steels and treatments.

Fatigue Tests in a Notched Condition

A more practical, and direct, line of attack has been the use of fatigue tests of various materials in a notched condition. One of the findings has been that a notch, like a corrosive attack, lowers the fatigue strength drastically and tends to level off the fatigue strengths of a steel in various conditions though the tensile strength varies considerably.

The assumption has been made by some experimenters that the drop in fatigue strength is solely a function of the notch (size not being considered) but comparisons of different steels in response to the same notch conditions have shown that the actual notch fatigue strength is a complex function of both material and notch effect.

There has been an attempt to clarify this situation by arriving at a notch sensitivity factor in a different way. If we divide the maximum stress at the root of the notch by the calculated mean stress over the root section we get a *shape factor* by which the fatigue strength would be lowered if stress were the only factor. Now it appears that this is an unusual case, or the limiting case, for the notch-fatigue strength is usually found to be above such a calculated value. By dividing the fatigue strength by the experimentally determined notch-fatigue strength the actual *notch effect factor* is obtained, which shows the amount by which the fatigue strength actually was lowered. The *notch sensitivity* of the material for the notched bar used is then obtained as a function of these two factors. If this analysis of notch-fatigue behavior is ultimately shown to be correct it will mean that the notch does not injure the metal (i.e. make the metal fail at an actual or true stress which is less than the fatigue stress) but in this sense may actually improve its behavior.

Size of the Part

Another factor which appears to be of importance is the size of the part, in plain fatigue and in notch-fatigue. One recent report on railroad axles suggests that a full sized axle at about 7-in. diameter had a fatigue strength about half that of 0.3-in. diam. bars taken from the surface of the full-sized axle.

There is now a serious attempt in Germany to formulate these notch effects and size effects as a new system of mechanics, called "material mechanics." This term distinguishes between the new mechanics and the old mechanics or theory of elasticity and signifies that the behavior of the part (mainly plastic behavior) depends on the material of which the part is made in its responses to stress concentrations and size effects.

Notched Bar Impact Testing

Upon turning to the older type of notched-bar testing, we come to a field which, in laboratory tests, is sharply differentiated from notched-bar fatigue testing. The feature of the behavior is a sudden and usually complete fracture through the notch section. The likelihood of failure of this type in the ductile steels cannot be predicted from the tensile test and this circumstance has led to a very considerable study of the notched-bar impact test. The work of the past decade has contributed materially to a better understanding of this field.

Commensurate with the importance of the notch effect, or possibly with our lack of understanding, a number of important meetings have been devoted to its consideration. After the Zurich meeting in 1931 of the New International Association for Testing Materials, the French test bar (10 mm. bar with 5 mm. notch) was adopted as the standard small bar, the test temperature to be about 70 deg. F. Although this standardization guarantees uniformity of test results in all countries using the standard bar, the test that was adopted merely samples the behavior of the steel at one temperature and one striking velocity, with one specific notch effect. To students of notch behavior it must be clear that considerable more work is necessary on the development of an adequate test procedure and on correlations with service behavior. A start along this line has been made.

The ASTM held an important symposium on notched bar and impact testing at its 1938 meeting, which covered both practical and theoretical aspects. Among other things it was recorded by Messrs. Riegel and Vaughn that notched bar testing has been highly successful in controlling the purchase of steel and subsequent fabrication into parts subject to very trying service. The writer proposed that the level of the cohesive strength should be obtained by means of the "match" point, at which the steel changes from ductile to brittle behavior. Two steels can have closely the same impact value in the standard test, or even the same notch toughness, and yet vary considerably when tested at a lower temperature or with a different notch effect. The writer also proposed the use of a modified Moser test which is based on the 10-mm. bar, instead of the 30-mm. bar, with the width varying from one half to three normal. Results obtained by this method at the General Electric Co. and the Caterpillar Tractor Co. were contributed to show its utility.

Finally, a more complete analysis of the behavior of a steel can be made by recording the stress-strain relationships during fracture. Schuster, at the memorable 1937 meeting of the Manchester Association of Engineers, observed that the point of crack formation gave indications of the resistance of the steel to crack formation and to the spreading of the crack, once formed.

It is clear that mere agreement on the small Charpy bar as a standard test bar and on room temperature as a standard test temperature is only a start, though a highly desirable step. The urgent need is a precise testing procedure which is capable of predicting the probable behavior in a particular service. Whether the number of failures in service due to deficiency in notch toughness is large or small, the engineer should be able to guard against this type of failure by design and selection of materials, and do it on a "sound engineering basis."

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Metals in Airplane Construction

by J. B. Johnson

A decade ago wood, alloy steel and aluminum alloys were used in approximately the same amounts for airplane construction. Today metal is used almost exclusively where high performance is the goal and is receiving more attention in the field of the cheaper, light commercial airplane.

Preponderance of Aluminum Alloys

Metals are very adaptable to the design and fabrication of the smooth, stressed skin monoplane which has become the standard

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type throughout the world. Aluminum alloys, which have been developed by a broad and consistent research policy, are being used by the majority of aeronautical engineers. Several alloys are available for specific purposes in all forms: Castings, forgings, extrusions, bar, sheet and tubes. Eighty to ninety per cent of the total structural weight of the modern high performance airplanes is aluminum alloys.

Great improvements have been made in manufacturing riveted joints and in the application of spot welding in order to reduce costs and obtain a super-smooth covering since skin friction and interference produce appreciable drag at speeds in excess of 250 m.p.h.

The Use of Magnesium

Magnesium alloys have not been employed to the same extent in this country as in Europe largely due to the availability of aluminum alloys, the lower corrosion resistance of magnesium, and the greater difficulties in fabrication. The strength-weight ratio of magnesium base materials in thin sections indicates no marked advantage and the lower hardness and modulus adversely affects the bearing strength at the joints. However, with the use of thicker sheets and of cast, extruded and forged members, the lower density material has the advantage. The extensive use of cast magnesium alloy wheels has demonstrated that magnesium castings are dependable under severe service. The chemical stability of these alloys in the presence of salt water has been greatly improved so that more extensive usage is assured.

Changes in Steel

Steel compositions have changed very little for several years. Three and one-half (3½) per cent nickel for utility and screw machine parts, and chrome-molybdenum steel for fittings and tubular structures are the standard types. Attempts to heat treat parts fabricated from these steels above an allowable stress of 200,000 lbs. per sq. in. have not been very successful, due to their inherent weakness under suddenly applied loads whenever the design requires abrupt changes in section. A less sensitive weldable steel which will permit an allowable design stress of 250,000 lbs. per sq. in. is one of the needs of the industry.

Arc welding has become a worthy competitor of oxy-acetylene welding for the fabrication of welded structures as the result of the improvement in electrodes.

Stainless Steel

The high tensile, corrosion-resistant steel containing 18 per cent chromium 8 per cent nickel has been used successfully in several airplane structures and a school of design is gradually being evolved which will take full advantage of its outstanding properties.

The nickel base alloys are pre-eminent where the combination of corrosion and heat resistance is required. The non-magnetic, heat-treatable alloys are replacing steels for certain critical parts.

Some Related Articles in METALS AND ALLOYS

"Metals Used in Aircraft Construction," by B. Stoughton—Jan., 1930.
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"Bright Annealing of Seamless Steel Aircraft Tubing," by H. R. Lewis—Dec., 1937.
"Beryllium-Aluminum Alloys for Aircraft Pistons," by J. B. Johnson —Apr., 1938.
"Airplane Propeller Blade Life." by J. B. Johnson & T. Oberg—Oct., 1938.
"Improving Aircraft Propellers by Surface Rolling," by G. Sachs—Jan., 1939.

Research

by John Johnston

According to such information as is available, the number of industrial research groups in the metallurgical industry increased by about 50 per cent between 1927 and 1938, and in these groups during this period the total research personnel more than doubled, the increase, both relative and absolute, being considerably greater in the ferrous than in the non-ferrous field.

This enhanced interest in systematic investigation of the many technical problems facing the metallurgical industry in its endeavor to meet the more and more exacting demands of the designing engineer, and indirectly of the public generally, is reflected in the much larger number of first-class papers published by American metallurgists now as compared to a decade ago, when METALS AND ALLOYS was started. The interpretation of many phenomena which then were obscure is being clarified and brought into a more philosophic system, and the newer views are being accepted so generally that we may even expect soon to see them incorporated in metallurgical text-books.

We have as yet taken only a few steps on the infinitely long road towards complete understanding, but we are surer of its immediate course and going faster, yet more safely, along it than ever before. There is a more widespread confidence in the efficacy of real knowledge, as opposed to hunches, in promoting the improvement of the metallurgical arts; and less attention is being paid to "explanations" in terms of words which themselves are vague and in need of explanation.

This is not to state that the behavior of a metal is not significantly affected by factors beyond our present means of apprehension, visual or otherwise; indeed it is more than likely that some of the present puzzles will not be solved until science succeeds in developing more powerful tools and more searching methods of investigation. Yet much remains to be achieved by proper interpretation of results obtainable by tools and methods now available in the careful hands of competent experimenters; and there are many reasons for faith that the next decade will bring forth a still better understanding of how best to win metals and to combine and shape them to fit each of the multifarious uses to which metal is put.

With the increase in number of men experienced in metallurgical research there is likely to be a larger number of significant papers, which may necessitate some modification of present methods of publication; and METALS AND ALLOYS before its twentieth birthday may face still greater difficulties in attempting to furnish its readers with a satisfactory map of the ground being gained in the battle against ignorance. There will continue to be differences of opinion so long as the evidence is insufficient to bring everyone to the same conclusion; but let us not take ourselves and our differences too seriously and remember that without such differences the metallurgist would be in a sort of Nirvana with little fun and, possibly, no job.

Some Related Articles in METALS AND ALLOYS

"Current Metallurgical Research at the Bureau of Standards," by H. S. Rawdon—Oct., 1929.
"Industrial Progress Made through Research," by W. R. Whitney—Feb., 1930.
"Cooperative Metallurgical Research—How?" by H. W. Gillett—Dec., 1931.
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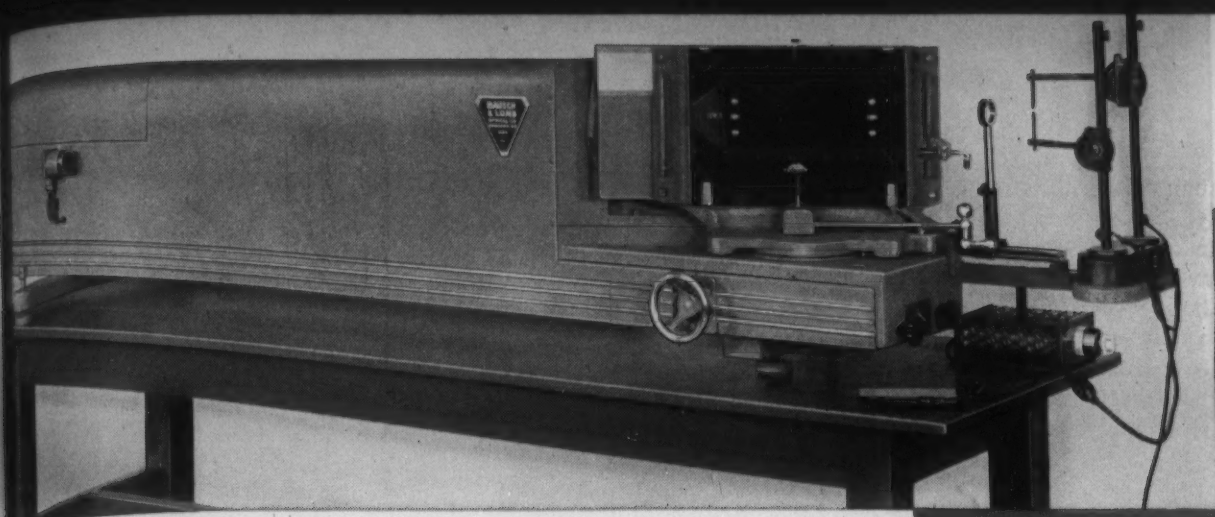
Gray Cast Iron

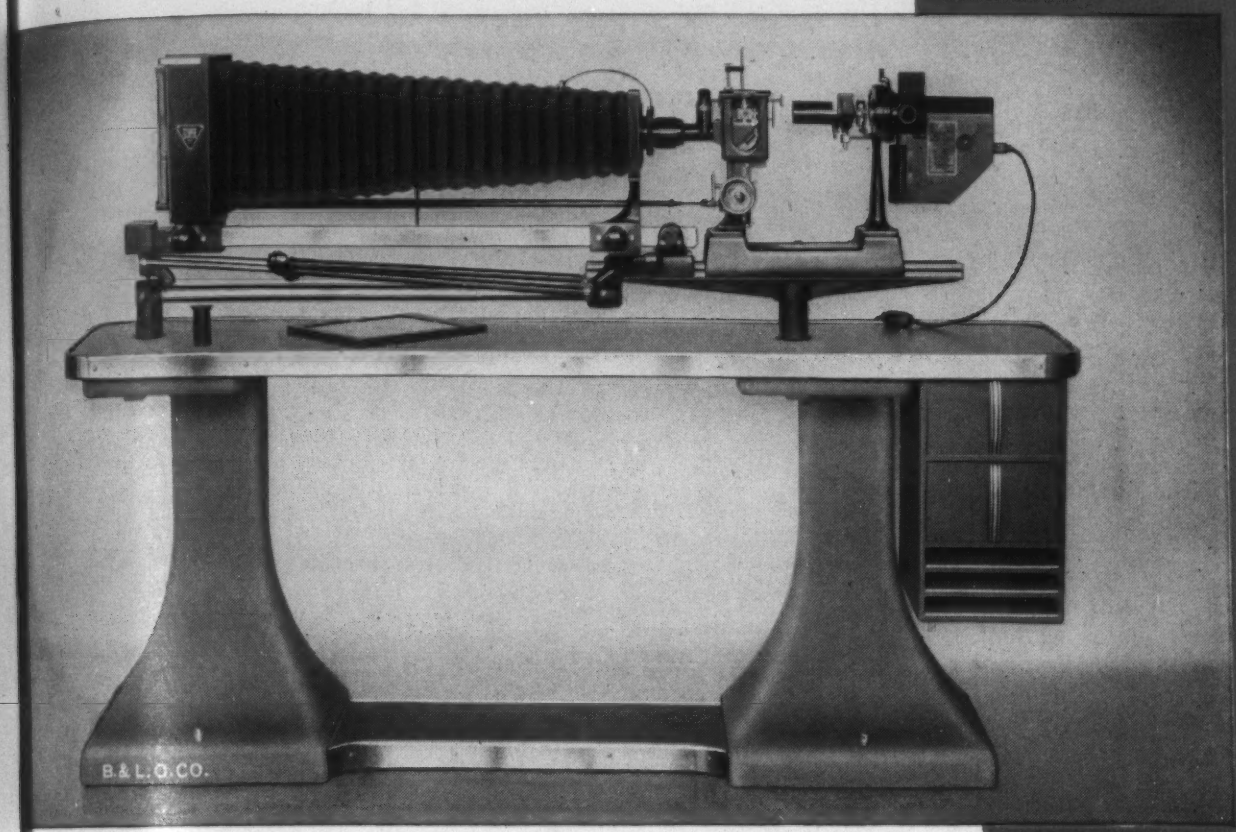
by James T. MacKenzie

The decade has been marked by development rather than by discovery in the gray iron industry.

Superheat

The discovery of the effects of superheat by Elliott and Piwowarsky in the previous decade has been assiduously followed up by a number of investigators with the result that we have a clear conception of the effects of superheating with quite a satisfactory hypothesis for these effects, i.e., the submicroscopic silicates, etc., but this is not universally accepted and work still continues. The discovery of germination or inoculation by Meehan in the early 20's has been followed by an enormous amount of research both technical and practical and has contributed greatly to our understanding of graphitization phenomena and control of structures.





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The alloys—chromium, copper, molybdenum, nickel, titanium, and vanadium—have been studied both singly and in combination though, of course, not exhaustively since the combinations, especially considering the basic compositions available, are almost infinite. The general principles governing their application have been fairly well cleared up though much work remains to be done. The austenitic alloys, Ni Resist and the high chromium irons, have been developed for corrosion and heat resistance, and the martensitic alloy, Ni Hard, has proved remarkably successful for wear resistant service.

Heat Treatment

The principles of heat treatment have been the subject of much study and this includes the effect of section size, chill casting, nitriding, etc. Centrifugal casting, both on metal molds and sand molds, has been developed to a high state of efficiency for pipe, brake drums, cylinder liners, and other cylindrical hollow bodies. Although it was well on its way in the early 20's, centrifugal casting has really come into its own during these last 10 years.

The unique properties of cast iron due to the presence of graphite have been studied by a number of investigators. Notable has been the study of damping capacity, wear and corrosion resistance, machinability, freedom from galling and seizing, and insensitivity to notches, etc. This has developed into the cast iron camshaft and other automotive parts not thought of 10 years ago. Even crankshafts are now under test with excellent results.

Correlating Tests

The relation of tensile, compressive, torsion, and shear strength to transverse modulus of rupture has been correlated with the elastic and plastic behavior of the material which is due to the size, shape, and distribution of the graphite. The elaboration of the behavior of cast iron under combined tensile and bending stresses by Schlick at Iowa State College has resulted in the first rational method for the design of cast iron pipe.

Foundry practice, which is essentially the art of making a sound casting true to pattern, has been studied in detail. Sand control, gating and risering, facings, molding and coremaking have been studied and much work has been done to get the principles involved before the designing engineer. The electric furnace has contributed greatly to ease of production and to research. The cupola has been studied intensively and has been equipped with controls for blast volume, temperature, distribution, and humidity.

Technical Contributions

Notable has been the contribution of technical societies, institutes, and authors. The report of the Subcommittee on Impact of the American Society for Testing Materials; the two symposiums of the American Foundrymen's Association and the American Society for Testing Materials; the "Cast Metals Handbook" and "Alloy Cast Iron" of the American Foundrymen's Association; the work at Battelle Memorial Institute and the Bureau of Standards, at the Universities of Illinois, Michigan, Ohio State, Wisconsin, and Iowa State College, to mention only a few, are of outstanding importance in this country while abroad the British Cast Iron Research Association, the technical schools and institutes at Aachen, Düsseldorf, and Darmstadt have made most important contributions during the decade.

Several good books have appeared in addition to the society publications just noted: Moldenke's Second Edition of "Principles of Iron Founding" in 1930, Piwowarsky's "Hochwertiger Grauguss," Hurst's "Metallurgy of Cast Iron" and "Melting Iron in the Cupola," and Bolton's "Gray Cast Iron." The Alloys of Iron Committee have covered the alloy cast irons specifically, and the basic principles of cast iron generally, in their remarkable series of Monographs.

Some Related Articles in METALS AND ALLOYS

"Some Elementary Facts about Cast Iron," by G. M. Enos—July, 1930.
"Cupola vs. Electric Melting of Gray Iron in a Specialty Foundry," by E. A. Wise—June, 1933.
"Nitricastiron," by V. O. Homerberg & D. L. Edlund—July, 1934.
"Continuous Pouring of Ford Cylinder Blocks," by E. F. Cone—Nov., 1935.
"Notes on the Graphitization of Gray Cast Iron," by R. M. Parke, V. A. Crosby & A. J. Herzig—Jan., 1938.
"The Brackelsberg Furnace as a Foundry Melting Unit," by E. F. Cone—May, 1938.
"Factors Affecting the Life of Cast Iron Ingot Molds," by F. P. Peters—May, 1938.
"Treating Cast Iron with Caustic Soda," by T. L. Joseph, F. W. Scott & M. Tenenbaum—Dec., 1938.
"Silicon Carbide Additions to Cast Iron," by J. A. Boyer—Jan., Feb., 1939.

Welding

by C. A. McCune

The progress of welding is usually indicated by comparing the improved or existing applications with those of several years previous to the time the comparison is made. But today, thanks to the metallurgists, physicists and engineers of the United States of America, the new developments in steel production and the formerly unheard of steel fabricated articles, welding advance might well be compared to those of yesterday.

Within the past year many developments have been made in welding apparatus by both the gas and electric groups as well as improvements in materials by manufacturers of gas welding rods and electrodes all of which have contributed to what might well be considered the production of perfect welds at such low costs that fabrication by any other method would be prohibitive. On the other hand in any number of cases no other means than welding could possibly have been used.

A complete review of the accomplishments of welding from streamlined trains to electric refrigerators in the past year would cover a great deal more space than is permitted in this brief review but the following may be considered a cross section of outstanding industrial applications.

All Welded Ship

Probably one of the greatest advances during the past year, at least to some of the pioneers in the welding field, was the recent launching of the 18,500 ton all-welded oil tanker by the Sun Shipbuilding & Dry Dock Co. This vessel which is 521 ft. long, has a capacity of 6½ million gal., is one of three all-welded vessels built by the Sun company for the Atlantic Refining Co.

A considerable amount of research work was successfully carried out during the past year on cutting and temperizing of structural steels. Everyone knows of the advantages of gas cutting. In ordinary steels the heat effect due to gas cutting is generally negligible and in certain special steels preheating or flame softening is necessary. During the past year exact techniques have been developed particularly for steels used in the structural steel industry.

Flame hardening, while not new, is now being used in regular production work. Welderies are now accustomed to flame cut, arc weld and to flame harden special wearing parts as a regular routine procedure.

Welded Rails in Track

The potential possibilities of welding a main line railroad track are receiving important consideration. One estimate shows that the railroads can save as much as $100,000,000 a year by the elimination of track joint through welding. A considerable amount of research work in this field has been reported during the past year on rail joints welded by gas, arc, resistance and thermit. The results are decidedly in favor of welding.

The day is soon coming when one may go to the factory and pick out an all-welded pre-fabricated home ready to put on the site, in much the same fashion that he will buy his furniture. All that will be necessary is to connect up water, light and gas. This is not an idle dream. Actually such homes are now available, and welding has made possible their construction.

During the year the American Welding Society issued its tentative rules for fusion welding steam, oil or air piping in marine construction. With the general acceptance of this code it is expected that most of the pipe lines in new ship construction will be all welded.

A Welding Handbook

The American Welding Society issued its first Welding Hand-

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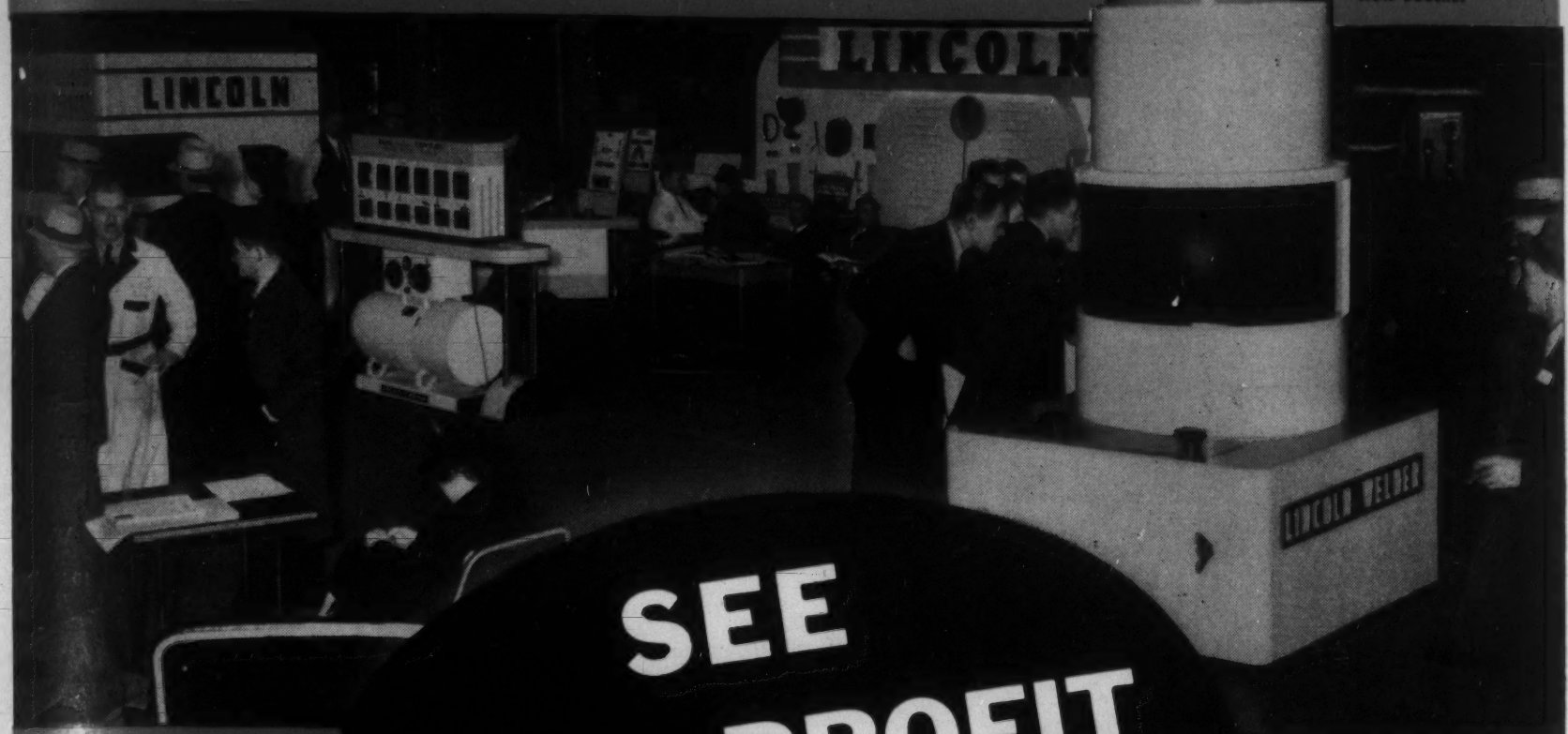

Look into the latest in arc welding at the Lincoln exhibit. This giant model of the "Shield-Arc Jr." is one of the demonstration booths.

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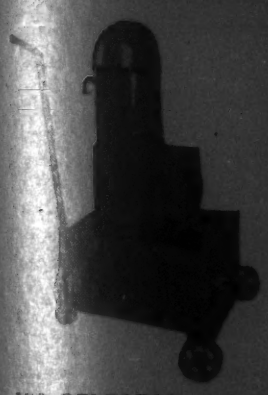

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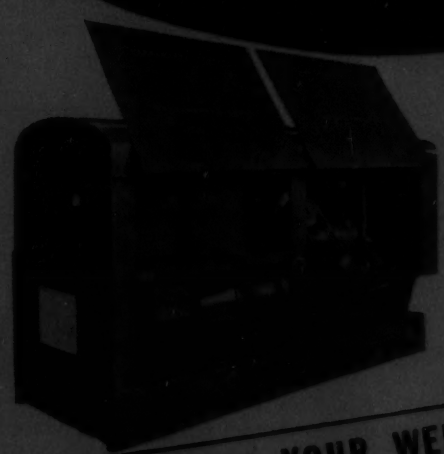

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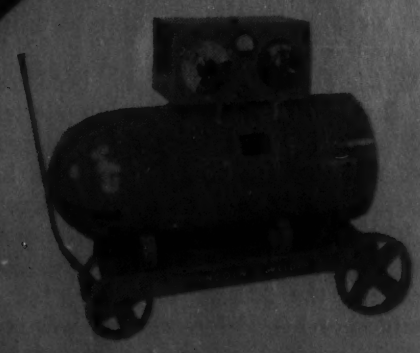

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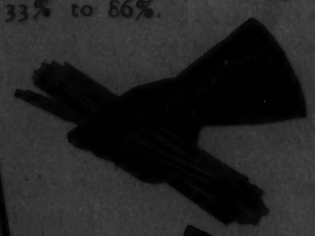

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book—a book of some 1200 pages written by more than 60 of the leading welding authorities of this country, and reviewed by some 257 other specialists. This represented the combined efforts of the leading welding talent of the United States.

A very considerable amount of progress has been made in the application of welding to oil well casing strings. Although the welded joint is not universally accepted as yet in this particular application, the greater percentage of casing strings is of the welded variety. A considerable amount of research work has been carried out in regard to the welding of low alloy steels used in the construction of such casing pipe. One of these strings 8100 ft. in depth was fabricated by the Carter Oil Co.

The first all-welded steel frame multi-story building was completed during the year under the New York City Building Code which now permits the use of welding.

Welding and Bridges

With the general acceptance of the AWS Code on Design, Construction and Repair of Highway and Railway Bridges, quite a number of bridges received a new lease on life. Some of these old bridges have been badly corroded, others not designed to carry modern trucks can be reinforced by welding to accomplish this. Welding permits repair or strengthening of these bridges at a minimum cost.

Non-destructive methods of weld inspection by the Magnaflux method and radiographic methods has become accepted practice for all important work.

The 13-story Woman's Hospital of Pittsburgh was erected in 58 noiseless working days; 100 tons of steel were required and the work was carried out less than 200 ft. away from the Eye and Ear Hospital and the Children's Hospital.

More and more the entire machinery and tool building industry is looking towards welding as a matter of economy and improvement of product. Welded steel in conjunction with welded castings is generally the accepted answer. Gas cutting plays a necessary and important part in this work.

The Automobile and Welding

Few of those who ride in automobiles appreciate that the modern car would cost twice as much and be of a much inferior construction were it not for welding; 3000 to 4000 welds are regularly made on a production basis in the modern automobile. High speed methods of production have been developed so that spot welds follow spot welds so quickly that the eye is unable to follow the movement.

Writing welding papers becomes big business particularly as, during the year, a leading electric company distributed some $200,000 in prizes for the best papers presented during the year. Several important power companies have installed all-welded high pressure power piping turbines operating with steam of 1250 lbs., at 950 deg. F. Several installations of this sort were recently completed by the Public Service Co. of Newark, N. J. Huge parts for the 200-in. telescope, the largest in the world, to be mounted at Mt. Palomar, Cal., was completed and sent on its way.

Welding in the construction of barges has practically become the standard method. Most of the modern barges are now constructed by welding instead of riveted or wood construction.

Welding in Diesel Engines

Importance of welding in the body construction of diesel electric locomotives and of the new streamlined trains is generally accepted. Quite a number were constructed during the past year using welding. Flame cutting assisted in the production of two steel plate fly wheels, the largest and heaviest made in steel plate. This required producing plate of 9⅛ in. thickness, weighing 56,215 lbs. Welding played an important part in the construction of the new steam electric locomotives produced by the General Electric Co. for the Union Pacific Railroad. Steam was generated by an all fire steam boiler of 1500 lbs. steam pressure and operates at 2500 kw.

Research

In depicting a year's progress in the welding field it is essential to refer to the enormous amount of research work along scientific and engineering lines being conducted by industry in the various laboratories, supplemented by the well-rounded program of research on a cooperative basis fostered by the A. W. S. This cooperative effort alone involves an expenditure of about $100,000 a year. On the various committees are serving 250 research workers comprising the leading scientific talent of this field in this country. Some 70 investigations are under way in the university laboratories. This is supplemented by coordinated programs in industrial and governmental laboratories.

Critical digests of the World's literature have been made and published on 35 selected topics. Each of these involves a review of some 500 articles written in several languages and scattered in many technical journals. Such investigations as the fatigue of welded joints at the University of Illinois are supplying the basic data for the design of structures subjected to dynamic stresses. Other investigations of an equally basic nature are being conducted by Massachusetts Institute of Technology, Ohio State University, Rensselaer and many others.

It is evident that the future of welding is definitely related to the future of steel and all other structural metals.

Some Related Articles in METALS AND ALLOYS

"Oxyacetylene Welding of Alloy Steels and Irons," by J. H. Critchett —Nov., 1931.

"Automatic Arc Welding of Steel Sheets," by A. M. Candy—Nov., 1931.

"Copper Brazing in Controlled Atmosphere Furnaces," by H. M. Webber—Nov., 1931.

"Metallurgy of Some Variables in Arc Welding," by F. R. Hensel & E. I. Larsen—Nov., 1932.

"Lowering Welding Costs by Careful Selection of Steels," by W. E. Stine—Apr., 1934.

"Spot Welding the Light Alloys," by R. H. Hobrock—Jan., 1935.

"Silver Alloys as Brazing Materials for Spuds in Tank," by H. A. Folgner—Jan., 1937.

"Titanium in Low Alloy Structural Steels for Welding," by G. F. Comstock—Feb., 1939.

"The Continuous Welded Rail," by H. W. Gillett—July, 1939.

Metallurgical Education

by Robert F. Mehl

Metallurgical education has been in a period of unusually rapid development during the last 10 years. In an article as brief as this, one can only indicate the nature of this development and state those directions in which progress should be made in the future.

Educators are keenly aware of the responsibilities they bear to industry in the training of metallurgists. Limited to four years for converting a high school graduate into a metallurgical engineer, and having only the last two of these in which to provide the student with training in purely metallurgical subjects, the instructor can hope only to train men well in basic science and engineering. Whatever the time available, this is surely the proper principle, and fortunately the industrial metallurgist insists that he wants this primarily.

The Most Serious Problem

Possibly the most serious problem the educator faces is the scope of his subject. To provide a man with proper instruction in the basic sciences, to train him in engineering principles, to create in him an understanding of the very broad subjects of physical metallurgy and the physical chemistry of metallurgical reactions, and to lead him to see the application of this training to industrial work—which is the ultimate objective—is not easy within the limitations of the curriculum. A great economy of effort and a close correlation of widely diversified subject matter is required. It is exactly in this respect that great progress has been made in the last 10 years.

Where a generation ago a training chiefly in descriptive metallurgy was held adequate, now a metallurgical student receives a training in a far broader field: For example, his physical chemistry must be excellent if he is to use a modern approach to open-hearth problems, or if he is to understand problems in corrosion; his physics and mechanics must be good if he is to understand forming operations and the interpretation of tests of mechanical properties. The technical college is now providing the basic training necessary for such an extended metallurgical curriculum

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with, I think, gratifying results, judging from the experiences of recent graduates. The metallurgist today is given a better basic training and is given a much broader training than heretofore. The metallurgical educator is not an educational fadist; there is little evidence for lack of balance in the selection of curricula.

Importance of Graduate Work

Graduate work is of lesser importance, but it is of great importance none-the-less. With the growth of industrial research the demand for men with graduate training has far exceeded our capacity to supply. Many industrial laboratories have in past years employed men with advanced degrees in chemistry and physics for research work. I do not think this policy will nor should continue; properly staffed faculties in metallurgy can provide sufficiently basic training to develop men in whose hands future advances in the science of metallurgy in both its theoretical and practical aspects may be confidently left.

Generally speaking, I think it can be said that administrators in educational institutions are not aware of the potentialities in metallurgical education (I do not have C. I. T. in mind!); perhaps industry could be useful in pointing these out. Industry itself, I believe, could show a steadier interest in the efforts of metallurgical schools, for, though it is trite, is there a more important raw material for industry than the products of technical schools? With the extremely rapid increase in the demand for trained metallurgists, which shows no signs of abatement, the metallurgical profession as a whole should be concerned with the development of metallurgical education.

Some Related Articles in METALS AND ALLOYS

"Specifications for Men—What Industry Expects Metallurgists to Know When They Graduate," by R. T. Ferguson, Jr.—Sept., 1934.

"Engineering as a Career," by F. P. Peters—Aug., 1937.

"Teaching Metallurgy in the High School," by W. E. McArdell & F. P. Peters—Mar., 1938.

Copper and Its Alloys

by W. B. Price

The production of O.F.H.C. (oxygen-free high conductivity) copper probably constitutes the most noteworthy improvement in the commercially pure metal during the last 10 years. As is well known, this copper has greater ductility than ordinary tough pitch copper, and is practically immune to embrittlement by reducing gases, particularly hydrogen. It is especially useful in welding where reducing gases are usually present, as well as in applications involving subjection to reducing conditions.

Age-Hardenable Alloys

The widespread use of age-hardenable copper alloys has been retarded by the difficulties of manufacture, necessitating close metallurgical control. This is perhaps particularly true with copper beryllium alloys. However, there is a growing use of age hardenable copper alloys, especially in applications where properties not obtainable by non-aging alloys are essential.

Copper-chromium and alloys based on copper-chromium including additions of silicon, zinc, cadmium, silver, beryllium and zirconium because of high electrical conductivity as heat-treated have been widely used in resistance welding electrodes. A relatively new high strength-high conductivity alloy uses small additions of iron and phosphorus to copper. Very close compositional control is essential to obtain high conductivity which may be as much as 90 per cent that of pure copper. Copper-beryllium is used on a small scale, mostly for spring parts in electrical devices, non-sparking tools, and the like. Some of the copper-beryllium ternary alloys, using only a few tenths per cent of beryllium, show promise because of a good combination of mechanical and electrical properties. The copper-nickel-aluminum alloys, also age-hardenable, are being advocated for use where excellent mechanical, forming, and joining properties together with good corrosion resistance are necessary. One recommended use is for large hot-headed bolts. The nickel bronzes (copper-tin-nickel) have been widely publicized in recent years as an age-hardenable casting alloy of superior strength and corrosion resistance.

Non-Age Hardenable Alloys

In the field of non-age hardenable alloys, various silicon bronzes have come into wide use. Such alloys as Duronze, Everdur, Olympic bronze and Herculoy have been particularly in evidence. These materials have excellent forming properties, are corrosion resistant to a wide variety of media, and are more readily welded than pure copper. The catch phrase is "the corrosion resistance of copper with the strength of steel." Besides silicon, these alloys generally contain one or more of various metals, such as manganese, aluminum, zinc or tin.

The older plastic bronzes for bearings have been supplanted to some extent by binary copper-lead alloys with lead running as high as 45 per cent. These are used in heavy duty applications as a thin layer on a steel sheet. Chromium bronzes (copper-tin-chromium) have been suggested for roll neck bearings and similar heavy applications, but so far their use has been rather limited.

Free Cutting Alloys

With the present increased machining speeds, materials with very free cutting characteristics are desired. The well known leaded brasses may be supplanted in some measure by tellurium and selenium brasses. One advantage of these addition elements is the avoidance of a low melting constituent which interferes with hot forming.

The use of controlled atmospheres for heat-treating copper and its alloys promises to do away with much of the pickling used at present to clean the metal after annealing.

Production of longer coils of strip is being made possible by various methods including the use of larger cakes, continuous casting, and welding two or more coils together.

Some Related Articles in METALS AND ALLOYS

"Everdur Metal—A High-strength, Corrosion-Resistant Engineering Material," by C. B. Jacobs, Jr.—Jan., 1932.

"Rapid Development of Patina on Copper," by J. R. Freeman, Jr., & P. H. Kirby—Sept., 1932.

"Adnic," by W. B. Price—Apr., 1934.

"Wrought Cu-Ni-Al Alloys," by D. K. Crampton & H. P. Croft—Apr., 1935.

"Copper Stools for Ingot Molds," by C. E. Williams & H. B. Kinnear—July, 1935.

"Brass and Copper Forgings—Their Manufacture, Properties and Use," by E. F. Cone—Dec., 1935.

"Beryllium and Its Alloys," by J. Delmonte—July, Aug., Sept., 1936.

"Copper Castings Alloyed with Be and Ti," by G. F. Comstock—Oct., 1936.

"Zinc Bronze—Composition 'C'," by F. G. Jenkins—Nov., 1936.

"Manufacture of Oxygen-Free High-Conductivity Copper," by E. F. Cone—Feb., 1937.

"Development of Power Cables," by W. H. Bassett, Jr.—July, 1937.

"Mechanical Properties of Four Binary Tin Bronzes," by C. G. Goetzel—Aug., Sept., 1937.

"Mechanical Properties of Copper at Elevated Temperatures," by L. H. Lorig, F. B. Dahle & D. A. Roberts—Mar., 1938.

"Cupaloy in the 'Time Capsule'," by P. H. Brace—Nov., 1938.

Open-Hearth Practice

by Leo F. Reinartz

There is no evidence that any fundamental changes will be made in open-hearth practice in the near future.

Three Major Developments

During the last year progress has been indicated by three interesting developments in the manufacture of steel by the open-hearth process:

1. A plastic chrome mixture has been rammed into the hearth of an open-hearth furnace and burned into a monolithic structure which, it is claimed is giving good results.

2. Several refractory companies have taken a leaf out of European furnace practice and have produced basic bricks for open-hearth furnace roofs. So far, at least 12 to 15 partial roof installations have been made. In most instances, sections along the front and back walls in the vulnerable parts of the roof have been installed. In the near future it is probable that some com-

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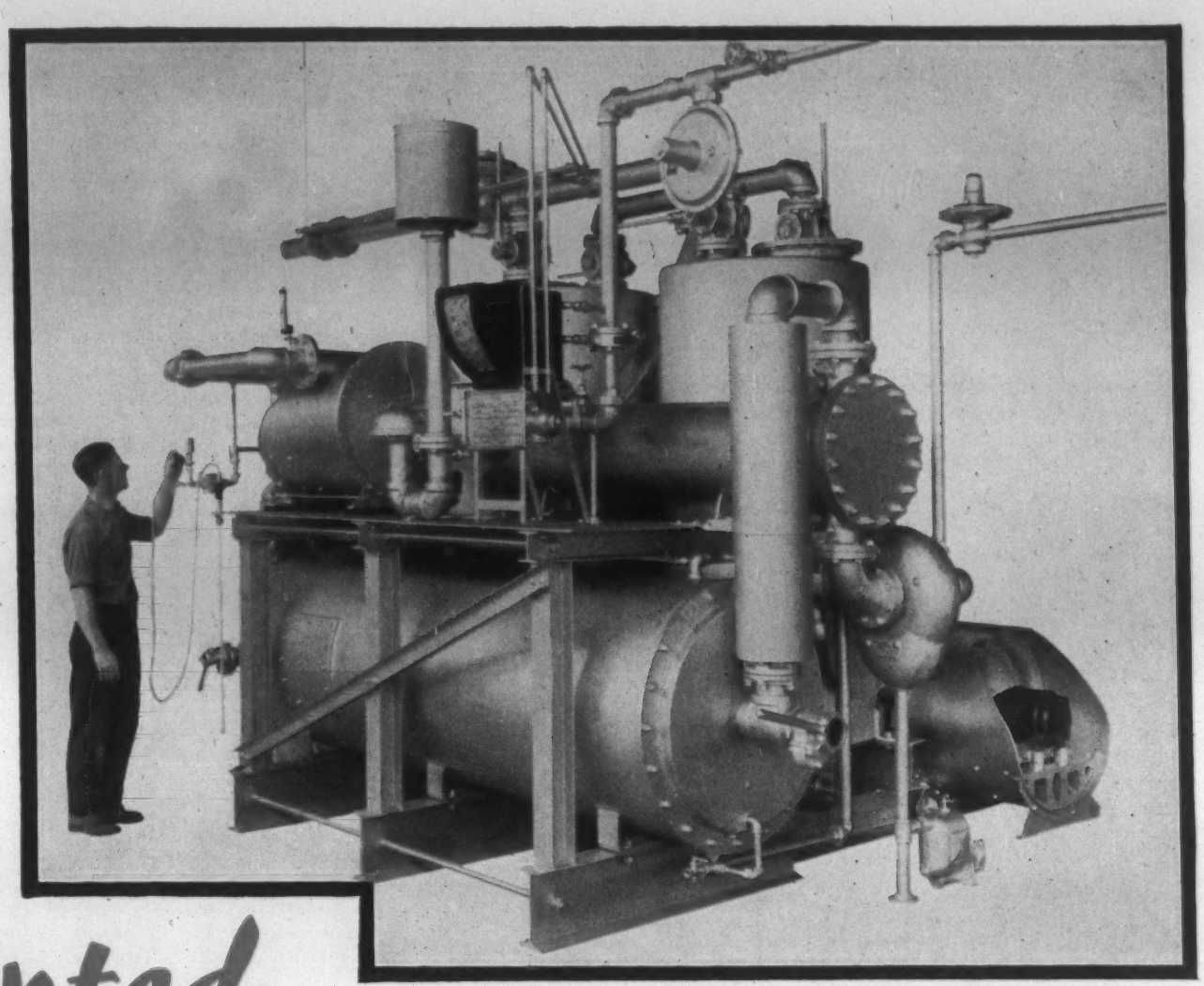

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pany will install a complete basic, suspended roof on a large open-hearth furnace. Added weight, radiation, hazard of spalling, and method of brick suspension are some of the problems that must be solved.

3. Temperature measurements in the bath of the open-hearth furnace are becoming more practical; at least two schemes are being used experimentally with good success.

Refractory companies are cooperating with operators to produce brick which can be installed in various parts of the open-hearth furnace system so that a campaign can be lengthened without serious intermediate costly repairs, and in order to prevent slowing up of the furnace towards the end of a campaign. In this development basic brick are used in front walls and on sloping back walls. Ports and furnace ends down to the floor level are lined inside with basic brick. This decreases wear and tear on ports, end walls, and decreases slag accumulations.

An unique slag pocket design has been tried which makes it possible to remove slag during the campaign of a furnace. This should help decrease deterioration and clogging up of checkers.

Insulation

Furnace insulation up to the charging floor level is standard practice in most open-hearth shops. Above the floor level the practice varies depending on the kind of steel made, skill of operators, economy of design, as well as type of fuel used.

In one open-hearth shop, a new principle of roof insulation is being tried out with promise of success. In another instance, a design, current in boiler practice for several years, has been adopted experimentally in open-hearth door and frame construction so as to reduce upkeep cost and save heat.

All these improvements, plus insulation, should decrease fuel consumption and increase hearth temperatures. If temperatures up to 3300 deg. F. can be reached, melting of scrap and pig iron will be speeded up and the overall efficiency of the furnace improved. By having excess heat available during the refining period, the open-hearth melter should improve the quality of the steel.

Automatic Control

Automatic control of furnaces has gained some adherents and lost others. It appears that the use of automatic draft control is increasing in popularity. Operators have had to be satisfied with some increase in furnace repair cost in order to secure other advantages connected with low draft practice, such as less metal oxidation and lower fuel consumption.

Many claims have been made for synthetic dolomites and magnesites. In general, the dolomitic compounds give relatively good results for "hot patching" and maintenance of furnace bottoms. Good results as bottom building materials have been reported for practically all the magnesites which various companies are placing on the market today.

Scrap prices are rising. There will be a tendency to increase the percentage of hot metal in shops where ore burden and blast furnace operating costs are low, and where burnt lime can be used without detriment to the quality of steel produced.

Metallurgical Progress

From a metallurgical standpoint, work continues actively on balanced charges, balanced slags, and close control of every open-hearth operation from the charging to the stripping operations. Throughout this development the key-stone to better quality has been the drive to improve uniformity in practice and raw materials. Progressive executives are looking ahead of the open-hearth department and are stressing uniformity in the production of "hot metal" in the blast furnace for open-hearth furnace use. Physically "hot" molten iron having the proper silicon analysis for the local conditions involved is a prerequisite for quality steel production.

More and more, metallurgical observers are becoming adjuncts and assets to the open-hearth superintendent in this drive for improved quality. Almost universally they report directly to the chief metallurgist.

Careful attention is being given to training the open-hearth organization in the rhythm of steady, regular charging, uniform speed of melting and refining, as well as reducing tapping and casting delays. These practices, in connection with uniform charges, and standardized refining technique, assist materially in producing steels which will meet the rigid specifications required by present-day metallurgical and physical needs of the trade.

Never before, has the word quality meant so much to the steel-maker. Never before, has he organized his operations so intelligently and enthusiastically as competition has forced him to do in recent months.

The open-hearth operator's slogan continues to be careful attention to the details of operations, continuous production, and uniformity of metallurgical practice from heat to heat.

Some Related Articles in METALS AND ALLOYS

"Fundamental and Applied Research on the Physical Chemistry of Steelmaking," by C. H. Herty, Jr.—Dec., 1930.

"Manufacture of Rimmed Steel Ingots," by J. H. Nead & T. S. Washburn—Mar., 1934.

"Recent Prgoress in Steelmaking Reported from Germany," by S. Epstein—May, 1935.

"Open-Hearth Roof Temperatures," by H. M. Schmitt—Dec., 1935.

"Insulation of Open-Hearth Furnaces," by E. F. Cone—Apr., 1936.

"Hearth Refractories for Steel Making," by W. J. MacCaughey & H. C. Lee—June, 1937.

"Seventh Report on the Heterogeneity of Steel Ingots," by F. P. Peters—Apr., 1938.

"Factors Affecting the Life of Cast Iron Ingot Molds," by F. P. Peters—May, 1938.

"French Appraisal of Rimmed vs. Killed Steel," by A. Sauveur—Dec., 1938.

Malleable Cast Iron

by H. A. Schwartz

Any industry lives only to the extent that its product fulfills adequately certain demands as to utility at a less cost than competitive materials. The malleable foundry is required to produce castings having certain minimal requirements as to strength, ductility, impact resistance, machinability and other physical properties, deliver them at the time required and at a price, for the finished article, which is less than that of the same article made of competitive materials. The relative importance of the various physical properties among themselves and in relation to delivery time and cost naturally vary with different applications.

Three Grades Recognized

Since the several requirements are not altogether compatible, it has been found necessary in the A.S.T.M. to recognize three grades of malleable differing in tensile strength and elongation. Some consumers, railways for example, regard high ductility and strength as the principal requirement and prefer grade 35018 of the A.S.T.M. specifications. Others, like the automotive industry, finding it impracticable for foundry reasons, to decrease their cross sections further to take advantage of higher strength, prefer the advantages of machinability and soundness accompanying the but slightly less ductile 32510 grade. The manufacturers of pipe fittings to whom soundness and machinability are of major importance have almost standardized on still weaker cupola malleable. All this is probably very good engineering judgment, for each obtains what to him are the most useful castings. This subdivision into a reasonable number of grades, each adapted to a specific purpose, is one of the most useful developments in the industry in the last decade.

Pearlitic Malleable

Recognizing instances where great strength is desirable, even at some sacrifice of ductility and machinability, the trade has developed a class of materials, somewhat illogically, called pearlitic malleable in which by virtue of heat treatment and/or alloy content the metallic matrix contains agraphitic ("combined") carbon. This is not always present as pearlite, as the name would seem to require, but may be martensite, granular cementite or anything between.

For these materials the A.S.T.M. has been able to develop only a descriptive form of specification which does not include any designation of properties. Since the materials have usually been developed each for a particular purpose, the possible combinations of properties found on the market are legion. It is an obvious advantage that this number should not be unduly restricted to the extent of depriving any user of a material which may be especially suited to his needs alone. The ability to vary these properties is an advantage to the malleable founder in getting and keeping business. It has been found relatively recently that the

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graphitizing and other heat-treating methods of the malleable industry are applicable to alloys which should be classified as steels and a whole family of graphitizable steels seems likely to come into being.

Short Cycle Annealing

The relative importance of early delivery, and hence of a short annealing cycle, seems to be declining. It is a fallacy to assume that shortened cycles are necessarily economical. The heat required to keep a well insulated furnace at temperature is trivial compared with that to heat the charge. It is quite possible to operate perfectly orthodox ovens on an annealing cycle of around 90 hrs. An increased investment, per annual ton of capacity, may reduce this to say 70 hrs. by the use of tunnel type furnaces. Very highly specialized furnaces can reduce this time considerably more, but at much increased capital outlay. On economic grounds cycles faster than around 70 hrs. are difficult to justify. If cost could be sacrificed, furnaces could be built in which the heat transfer would be made very rapid and quite short cycles result. It is hard to find users who will pay more for the faster delivery.

A still further decrease of time could be accomplished by the adoption of special compositions of metal. Such practices are regarded as dangerous by many because they all verge closely upon metal which will not be graphite free as cast and occasional worthless material might result which would not be caught by inspection.

Conclusions

It may be well to point out in conclusion that the last decade has added little to the known metallurgical fundamentals but much to their commercial application. The improvements of equipment used by the founder have not here been touched on and would make another story.

Some Related Articles in METALS AND ALLOYS

"Malleable Iron—Recent Progress," by H. A. Schwartz—Sept., 1931.
"What is Made of Malleable Iron?," by E. Touceda—June, 1938.
"Short Cycle Annealing of Malleable Iron"—May, 1939.

Corrosion

by F. N. Speller

On the whole, much more has been accomplished towards a clearer understanding of corrosion processes and methods of prevention during the past decade than in the previous 10 years. It is now generally recognized that corrosion depends both on the metal and the environment in which it is placed, and is therefore controlled by a number of variables and includes a multitude of problems; that in the presence of water it is the result of electrochemical reactions at anodic and cathodic areas; that all metals (except some of the so-called noble metals) tend to corrode in certain environments; and that this tendency is retarded or prevented by interposing between the metal and its environment some kind of barrier against continued attack.

Much has been learned about metal surface films (and also paint layers) by laboratory research in which electrometric potential methods have played an important part.

Useful Life of Metals—Symposia

The useful life of metals has been increased by improving their resistance to attack, use of better protective coatings, and improved environmental conditioning.

Later developments in corrosion-resistant metals and alloys was well covered in a series of symposia in 1936, a comprehensive correlated abstract of which will be found in METALS AND ALLOYS, November and December, 1937 and January, 1938 ("A Correlated Abstract on Corrosion and Corrosion-Resistant Metals and Alloys") by V. V. Kendall.

Protective Coatings

More attention is being given to descaling and treatment with inhibitors (such as phosphoric acid mixtures) with thorough drying of the metal prior to painting (for example, flame descaling). Zinc chromate and other slightly soluble inhibitors are now generally used in the priming coat. There is a marked improvement in paints for both atmospheric and underwater service, due largely to the better synthetic materials used in vehicles and improved formulation.

Bituminous coatings for pipe and other underground structures are now more reliable. The interior of steel water pipe is now usually protected by the newer plasticized coal tar or blown asphalt enamels applied centrifugally while hot to a thickness of at least 1/16 in. Portland cement mixtures are still more durable and are also applied mechanically to the interior of pipe.

For protection against corrosive soil, these bituminous materials are usually reinforced with saturated asbestos fabric to a total thickness of about 1/8 in. Where necessary, soil stress is prevented by application of an outer shield. The corrosivity of soils can now be determined with a fair degree of accuracy (about 75%).

Anaerobic bacteria have been shown to be very destructive in certain clays and mucks containing sulphates and organic matter in absence of free oxygen. Oxygen is released from the sulphates by these organisms.

Cathodic Protection and Inhibitors

Cathodic protection was first applied to underground piping in 1928, and has proved to be reliable and economical. When coatings fail the piping system can often be kept in good operating condition by impressing a regulated current on the metal with considerable saving in maintenance cost. Improved appliances and technique have been developed for this purpose.

Application of neutralizers and inhibitors to industrial water and brine systems is finding increased use in protection of air conditioning equipment, heat exchangers, gasoline pipe lines, etc.

The use of a few parts per million of hexametaphosphate of soda (the so-called Threshold Treatment) reduces scale formation and promises to be useful in controlling corrosion in water systems.

The new (Langelier) analytical control of anti-corrosion treatment of domestic water supplies is finding useful application and is probably the first step towards further important developments by water works chemists and members of the A.S.T.M. Committee on Water for Industrial Uses.

Caustic Embrittlement and Colloids

The problem of caustic embrittlement has been greatly clarified, mainly due to the work sponsored by the Joint Research Committee on Boiler Feedwater Studies. Embrittlement is a type of corrosion fatigue caused by simultaneous action of chemical corrosion and high concentrations of dissolved solids in contact with highly stressed boiler metal. Careful workmanship and improved design of modern high pressure steam boilers have eliminated dangerous stress concentration and high concentration of dissolved solids (two of the three destructive factors), and new organic inhibitors are giving promising results in low pressure boilers of older design.

Certain colloids have been proved to protect stressed metal from corrosion fatigue, as in the mud fluid in rotary drilling of oil wells. The oil industry now have their corrosion investigations highly organized with respect to refinery, production, and transportation problems. Oil cargo tanker corrosion problems are not yet solved economically, but the work is well under way. Once-through condenser tubes are still subject to wasteful attack. More frequent and efficient cleaning should greatly lessen localized corrosion.

The American Coordinating Committee on Corrosion was organized this year to afford a clearing house for information and to facilitate useful contacts between investigators in this wide field. A classified directory of investigators and problems is now being prepared by this committee.

Some Related Articles in METALS AND ALLOYS

"Embrittlement of Boiler Steel—a Correlated Abstract," by E. P. Partridge & W. C. Schroeder, June, July, Sept., Nov., Dec., 1935.
"Chromium-Nickel as a Corrosion-Resistant Alloy," by R. J. McKay—Dec., 1933.
"Deterioration of Cr-W Steels in Ammonia Gases," by P. R. Kosting—Mar., 1934.
"Cavitation Erosion of Metals," by W. C. Schumb, H. Peters & L. H. Milligan—May, 1937.
"Corrosion and Corrosion-Resistant Metals and Alloys," by V. V. Kendall—Nov., Dec., 1937; Jan., 1938.
"The Pitting of Stainless Steel," by W. A. Wesley & C. H. Lindsley—Dec., 1937.
"Use of Electron Diffraction in Studying Corrosion," by I. K. Landau—Mar., Apr., 1938.

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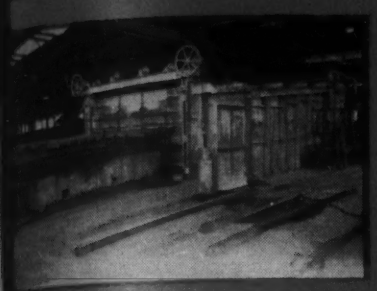
INDUSTRIAL FURNACES



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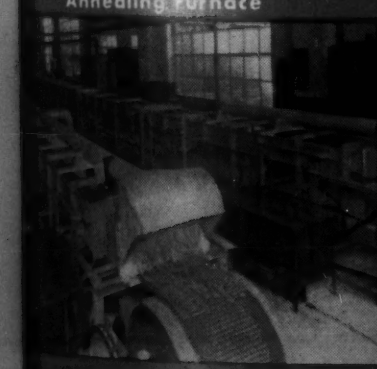

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A lot of water has gone over the dam since 1888 and a lot has been learned about industrial furnaces since then. This wealth of experience goes into every ROCKWELL furnace.

We have actually built thousands of furnaces—the views shown here illustrate only a few of the various types.

Our furnaces are built for capacities from ounces to tons—continuous or batch—bright or oxidized finish—full automatic or manual control.

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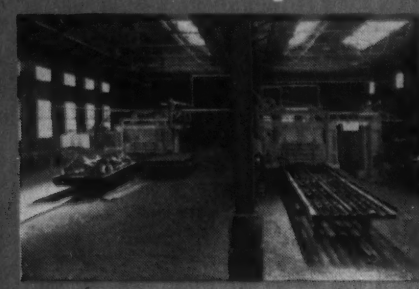
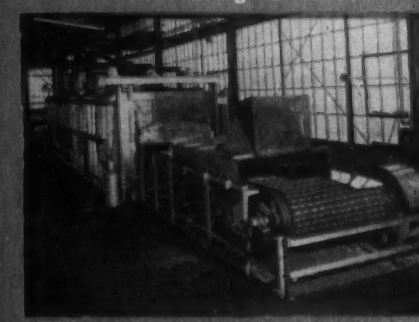
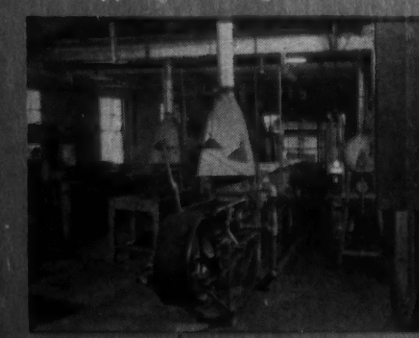


Battery of Fuel Fired Pan Type Annealing Furnaces



Fuel Fired Mat Chain Conveyor Type Annealing Furnace



Fuel Fired Continuous Belt Type Bright Annealing Furnace

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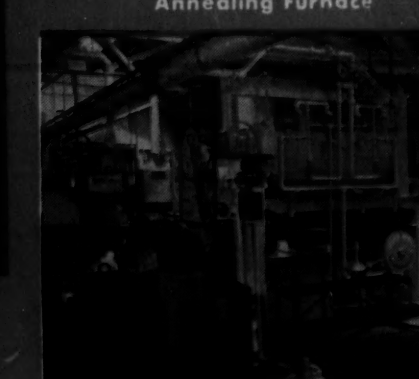

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W. S. ROCKWELL COMPANY

INDUSTRIAL FURNACES—ELECTRIC AND FUEL

50 CHURCH STREET NEW YORK, N. Y.

Vanadium

by Jerome Strauss

The importance of vanadium as one of the principal alloying elements of ferrous metallurgy is today as great or greater than it was at the beginning of the decade. Numerous changes have occurred in its applications, during these years, both in tool and in constructional steels, and these are briefly reviewed.

In High-Speed Steel

High speed tool steel (as distinct from air-hardening tool steel) began as a tungsten-chromium steel—that was in the early days of our century. Not long after its birth, the addition of a quarter per cent vanadium was tried and found to effect a marked improvement. By the time of the beginning of the World War, this amount had been increased until the standard composition averaged about 0.7 per cent. Higher contents had been tried and at least one brand contained close to 1 per cent carbon and 3 per cent vanadium. But all this was not too well understood—nevertheless in the most common composition (18 tungsten and 4 chromium) vanadium, and carbon, steadily increased until the former now averages about 1.1 per cent.

Recent studies have confirmed early experiences and, as fabricating technique improves, higher-carbon, higher-vanadium steels will appear in more widespread applications. Even now there is tonnage production of steels of 1 per cent or more carbon with 2 to 4 per cent vanadium. One may anticipate steels with still larger percentages with their greater cutting capacity and the consequent demand for sturdier machine tools.

In Low-Alloy and Carbon Tool Steels

In the carbon and low-alloy tool steels, the benefits of higher carbon and vanadium contents are being studied and appreciated. Especially noteworthy is the medium-carbon high-silicon, high-manganese steel containing 0.3 per cent vanadium or more and the approximately 1 per cent carbon steel with 0.45 per cent vanadium as its single alloying element. The former has been rendering, for close to these 10 years, exceptional service in both sharp and blunt tools subjected to extreme shock. The carbon-vanadium tool steel, a more recent development, is of interest due to affording the possibility of varying the depth of hardening over a wide range *without grain coarsening*—merely by adjustment of the time of heating and temperature used for quenching.

In Low-Alloy and Carbon Constructional Steels.

In the domain of constructional steels, it is perhaps not inappropriate to mention one type that remains unchanged. S.A.E. 6150 is still the pre-eminent spring steel where ease of manufacture and fabrication, plus the utmost in service, is demanded. Initial cost, only, restricts its applications, but this is secondary when service is severe and *overall cost per unit of performance* is the yardstick.

Among newcomers in the constructional field, the manganese-vanadium type is the most important. In the very low carbon ranges (about 0.2 per cent and less) it is important for its high useful strength and exceptional welding qualities. In higher ranges of carbon (up to 0.4 per cent) an unusual combination of high yield point and high ductility (and impact strength) is secured, after normalizing and tempering, quite equal to those obtainable in many other alloy steels only by quenching and tempering. These manganese-vanadium compositions are all characterized by exceptionally high endurance ratios. In both castings and forgings, these compositions have found widespread use.

Nitriding steels, aluminum-free and therefore free of the defects often encountered in steels of high aluminum content, are of the chromium-molybdenum-vanadium type. With 2 to 5 per cent chromium or more, ½ per cent molybdenum and ¼ per cent vanadium or more, a range of desirable properties is secured that is well suited to many applications of this hard-surfacing method. This type is equally usable in castings and in forgings.

Small Amounts of V

The contribution of vanadium in very small amounts (about 0.1 per cent or less) to the transverse properties of heavy forgings has grown so rapidly in the last decade that its employment for this purpose is now almost universal. Extension of the field of the very low vanadium steels is continuing (this is quite apart from such use in carbon tool steels) and may be confidently expected to make great strides in the very immediate future. As this is being written, a number of constructional steels with vanadium contents less than 0.05 per cent have been made which, though fine-grained, possess exceptional hardening capacity and have unusual toughness at high values of hardness. They promise to open up new metallurgical vistas.

Some Related Articles in METALS AND ALLOYS

"Nitriding Characteristics of Cr-Mo-V Steels," by J. Strauss & W. E. Mahin—Mar., 1935.

"Vanadium in Steel and Iron," by W. J. Priestley—Aug., Sept., 1938.

From Some Leading Metallurgical Engineers

Hard Carbides

by Zay Jeffries

Chairman, Carboloy Co., Inc., Cleveland

Of the total production of cemented carbides since their introduction in the late twenties, more than 95 per cent has been in the past decade. Prior to 1929, tungsten carbide with a cobalt binder was used exclusively. The applications were mainly for wire-drawing dies and cutting tools for cast iron and non-ferrous metals.

Variety and Application

Now the industry is rich, not only in the variety and number of grades of carbide, but also in the variety and number of applications. While tantalum and titanium carbides, intimately mixed with tungsten carbide, are now used for many purposes, the tungsten carbide grades greatly predominate. Cobalt is still the principal binder—in general, the more cobalt the tougher and softer the product. Grain size control has been superimposed on composition to secure properties not otherwise obtainable. Processes have been developed to commercialize the manufacture of large pieces and parts of unusual shape. The techniques of brazing tips to steel shanks and mounting die nibs in steel casings have been markedly improved. The improvement in grinders and in tool grinding has been revolutionary.

One greatly expanded use is for wear and corrosion-resistant parts. This field includes, among others, nozzles, guides, valve stems and seats, meter fingers and pawls, and chilling plates for hardening and tempering thin stock. One machine having 25,000 wearing-part pieces now runs for weeks without attention, whereas formerly changes were required three times daily.

An interesting new product, used for grinding-wheel dressers, small grinding wheels, glass laps, core bits, etc., is made by imbedding diamond fragments in cemented tungsten carbide.

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Influence on Other Industries

Year by year, the cemented carbide industry is having a more important influence on other industries. The abrasives manufacturers have developed wheels especially to grind the carbides. Certain of these contain crushed diamond. Machine tool builders have developed lathes and milling and boring machines with high speeds, increased power and improved means for chip removal. In some instances the new machines are designed to use only cemented carbide tools.

New and improved alloys have been commercialized because they could be successfully machined for the first time by cemented carbide. Among these are certain aluminum-silicon alloys and hard, fine-grained irons from a high steel charge. The use of machined parts made from difficultly machineable non-metallic materials has also been expanded.

A number of innovations in shop practice have resulted from the use of cemented carbide broaches. Some of these would be impractical with the older tool materials. Also, the carbides are used extensively for facing the wear surfaces of a large variety of gages. These include ordinary, as well as master, gages. The increased life is sometimes more than a hundred-fold.

Dies

The use of cemented carbide wire-drawing dies has become practically universal. There is constant extension of use to the larger dies, both round and shaped, for bar stock. The finish is excellent and the product can be held to close dimensional tolerances. Cemented carbide dies and mandrels are also used extensively for drawing seamless tubing.

Cemented carbide dies have been developed for shaping sheet metal in presses. Until recently, this application has been confined to relatively small dies, but now large dies are coming into use.

During the last few years the use of carbides for machining steel has substantially increased. Grades containing either tantalum or titanium carbide, or both, added to tungsten carbide, are especially suitable for steel-cutting.

Notwithstanding the marked strides made in quality, price reductions have been drastic. At the beginning of the decade the price was around $1.00 per gram, and now a sliding scale of prices ranges down to $0.113 per gram in quantities.

These high spots of a decade of progress but poorly reflect the significance to society of cemented carbides. Each modern automobile, truck, bus or airplane bears the imprint of cemented carbide in its manufacture. Telegraphic messages are sent more reliably and economically because cemented carbide contacts are used. It has even found its way into the home as a part of the grinding member in a kitchen waste disposal unit. Every time we use a modern telephone, or listen to the radio, or turn on an electric light, it is a practical certainty that cemented carbide has played a part in the manufacture of some of the equipment involved.

The Future

But even greater things are in store for the next decade. Cemented carbide is the hardest and most wear-resistant metallic substance available for tools, dies and machine parts. The trend is toward its judicious use to strengthen the weaker links in the chains of industrial devices. The new techniques, improved grades, greater adaptability to varied uses, and the lower prices, all tend to accelerate this movement.

Low-Alloy, High Strength Steels

by B. D. Saklatwalla
Partner, Saklatwalla & Foote, Pittsburgh

The past decade has witnessed significant advances in the steel industry, when viewed from the standpoint of applied research. Gratifying results have been due largely to a growing realization, on the part of scientists and metallurgists, of the commercial advantages to be gained by placing superior materials in the hands of designing engineers, and then cooperating closely with them to assure their satisfactory application. The immediate future affords great possibilities for the further development of steel alloys to meet the increasing demands of an ever-changing industrial civilization. Research of this character, if it may be so termed, backed by proper experimental engineering and sales development, is a certain and profitable means of increasing the tempo of business. Considering the highly competitive situation existing in the steel industry itself, and the real, and constantly growing, competition of the aluminum and magnesium alloys, plastics, etc., these new objectives of steel's technicians have appeared none too soon. They constitute the one logical and promising basis for building broader markets and re-establishing profit margins.

The development of low-alloy, high strength steels is a clear example of the tangible results to be derived from such purposeful research. Engineers generally, and transportation engineers in particular, now realize that ordinary carbon open-hearth steel performs its functions only at the expense of unnecessary dead weight, when compared with the superior steels of today. Low resistance to corrosion and abrasion were factors in excess weight. In most cases, therefore, carbon steel could not be used in a manner that took full advantage of its strength properties. The new materials should prove a boon to the railroads. With almost every avenue to lower operating costs closed to them by one restriction piled upon another, weight reduction and modernization of equipment loom up as hopeful directions in which to look for economy.

Carbon and Low-Alloy Steels Compared

The problem of providing proper materials for wholesale weight reduction in many branches of industry was not one relating to mechanical strength alone. It proved complex indeed when the need for an integration of several properties in a single steel was found essential to the purpose—strength; resistance to impact, corrosion and abrasion; ease of forming; satisfactory welding, without, in general, the necessity of stress relieving; adequacy for use in the as-rolled condition, without heat treatment; and, on top of all, low cost. Failing a satisfactory score on these counts, the objectives sought in the lightened structures could not be obtained. It was requisite that they should give a service life at least equal to that of the former, and heavier, structures of carbon steel, with initial and maintenance costs no greater; otherwise the full benefits of the lower operating costs striven for, could not be realized.

It was a big order, but, with a full knowledge of the requirements, a painstaking metallurgical research proceeded systematically with the creation, development, and commercial promotion of the low-alloy, high strength steels. These new materials have benefited all concerned—to the steel maker more profitable and wider markets; to the consumer greater efficiency and operating economy without sacrifice of a single advantage previously enjoyed.

Corrosion

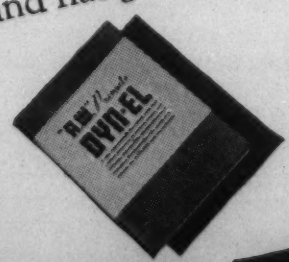
Following the greatly increased use of steel as a structural material since the turn of the century, it was inevitable that enormous losses, due to corrosion, should become apparent. In the development of superior open-hearth tonnage steel—which these new steels are in reality—the need for added resistance to corrosion was a prime consideration. Accordingly, the combination of alloys selected to provide strength was such as to materially increase corrosion resistance. The older high tensile group did not possess this important property, and therefore the reduction of section could be accomplished to a limited extent only. Their forming properties, weldability, and, in general, abrasion resistance, were also inadequate.

The new steels may be fabricated by customary processes, and with the existing equipment commonly found in the plants of fabricators. They possess their strength properties in the as-rolled condition without heat treatment, and ordinarily do not require preheating or stress relieving for welding purposes. They are produced by the ordinary open-hearth process and are available at a cost per pound which is only somewhat higher than that of carbon steel and not out of line considering their superior

. . . and the Tank is 900 Lbs. Lighter

Truck tank built of Dyn-el by PENNSYLVANIA FURNACE & IRON CO., Warren, Pa., for Wm. F. Crossett, Inc., of the same city . . . 3-compartment, 4,100 gallon, semi-trailer type.

Because of its greater strength and better fabricating properties, "A. W." Dyn-el is selected for use in the construction of this new type of truck tank . . . Built of hot rolled carbon steel, this 4,100 gallon tank, including manholes, piping, emergency valves, catwalk, hose tubes, trim skirting and under framing, weighs 5,200 pounds. Built of "A. W." Dyn-el, it weighs only 4,320 pounds—a saving in hauling costs of 900 pounds on the tank alone... and this lighter tank is actually stronger than the heavier job and has greater resistance to shock, fatigue and corrosion.



The 48-page book, "A.W." Presents Dyn-el, gives full details of savings in weight and cost possible with this new high-strength, flat-rolled steel. Diagrams, tables and charts cover a wide range of tests and properties. To executives, this book gives a quick picture of performance and costs. To engineers, it gives complete fabricating and design properties and table of sizes and weights. We will be pleased to send you a copy.

DYN-EL

ALAN WOOD STEEL COMPANY

MAIN OFFICE AND MILLS, CONSHOHOCKEN, PENNA. : : SINCE 1826 : : DISTRICT OFFICES AND REPRESENTATIVES—Philadelphia, New York, Boston, Detroit, Los Angeles, Seattle, San Francisco, Houston, Roanoke, Buffalo, Pittsburgh, Cleveland, Chicago, Cincinnati, New Orleans, St. Paul, St. Louis, Montreal. PRODUCTS INCLUDE—"A. W." Rolled Steel Floor Plate : : "Swede" Pig Iron : : Billets—Blooms and Slabs : : Sheared Steel Plates : : Hot Rolled Sheets and Strip : : Steel Products also furnished in Copper and Alloy analyses.

utility. Thus, structures may be built of them, due to the fewer pounds required, at a cost practically the same, or, in some instances, only slightly higher than that of similar structures constructed of carbon steel. All things considered, the properties of these steels are nicely proportioned to the desired results.

The superior low-alloy corrosion resistant steels are found either in the chrome-copper, or the nickel-copper groups. The chrome-copper group, originated in this country in 1922, has been developed to the present improved commercial grade with addition of silicon and phosphorus. The nickel-copper group appeared somewhat later. In England and on the Continent of Europe, chrome-copper steels have been used widely since about 1928, and seem to be the predominating type at present. The guiding factor in effecting a choice from either of these two main groups should be the actual performance shown for a number of years in the particular service required. This is especially true in evaluating their relative corrosion resistance. The life of any equipment is governed so definitely by the functions required of it that service history, unfortunate though it seems, appears to be the only reliable criterion.

In Transportation and Bridges

The low-alloy steels have gained prominence by their wide use in railroad transportation, where the immediate need for them proved greatest. Many service applications have been made, however, in other fields. The shipping industry has problems which parallel those of the railroad industry, closely, and their solution will be found in the adoption of the new steels. Weight reduction and corrosion resistance in static structures are also proving economical. In Europe the use of chrome-copper steel in the construction of a number of large bridges and transmission towers for electric power lines is particularly notable, and the percentage of weight reduction is most impressive. The Madagascar suspension bridge and the bridge over the Zambesi River, both in Africa; the Howrah-Calcutta bridge in India; the Chien Tang-River bridge in China; the Malarsee bridge in Sweden; the Ardeche to Teil viaduct and the Troy-Paris and Eguzon-LaCellette power lines in France, are examples of chrome-copper structures well worth detailed study. In special cases where transportation constitutes a substantial cost factor, the weight-saving possibilities of the new steels determine their use. For instance, the largest skyscraper in the East, located in Shanghai, and approximately 80 meters in height, was built of chrome-copper steel, fabricated in Germany, and shipped to China.

An "Engineering Eye-Opener"

Thus, the introduction of the "low alloy, high strength steels" has not merely added a few new products to the numerous existing types of so-called "high tensile steels"; it constitutes an important engineering development introducing large possibilities and new conceptions in engineering design. As aptly put by one prominent designer, they have been an "engineering eye-opener," not only awakening a consciousness of corrosion losses and of dead weight, but also providing the solution for these problems.

The broadening of their application, and further improvement in their uniformity and manufacture, should prove a powerful stimulus to future engineering and metallurgical progress. A sorely needed expansion in the steel demand of America, and indeed of the world, can be achieved through such new developments—those of a nature that will accelerate obsolescence and hasten the retirement of existing equipment and methods. In most cases the lower operating costs which may be realized through modern design, based upon the new materials available today, will force the replacement of old structures with those of the more efficient, hence more economical, type.

Some Related Articles in METALS AND ALLOYS

"Copper as an Alloying Element in Steel," by H. L. Miller—Oct., 1934.

"Low Alloy, High Yield Strength Structural Steels—An Extended Abstract"—Mar., 1936.

"Phosphorus as an Alloying Element in Steels," by H. C. Cross & D. E. Krause—Feb., 1937.

"Present Status of the Low Alloy, High Strength Steels," by E. F. Cone—Oct., 1938.

"Titanium in Low Alloy Structural Steel for Welding," by G. F. Comstock—Feb., 1939.

Chromium

by J. H. Critchett

Vice President, Electro Metallurgical Co., New York

The past decade has seen the greatest growth in the metallurgical use of chromium of any period in the history of the metal. Rapid commercialization of the stainless steels has of course been the outstanding reason. In the meantime, usage of chromium in structural and engineering steels, moderately corrosion-resistant steels, cast iron, and non-ferrous alloys has steadily increased.

Low-Alloy Chromium Steels

The development of low alloy, high strength structural steels for use in equipment requiring superior strength, corrosion resistance, and weldability is outstanding. Chromium is a basic ingredient which imparts strength and, together with copper or phosphorus, or both, imparts corrosion resistance to such familiar steels as "Cor-Ten," "Ductiloy," "Mayari R," and "Cromansil," among others.

In addition to increased use of the 1 per cent chromium, heat-treated engineering steels, a steel containing 3 per cent chromium, often with molybdenum, now accounts for some of the expanding use of chromium. This steel has high wear resistance and that combination of toughness and strength necessary for cylinder liners, crank shafts, and similar machine parts. Abroad it is being used in many high duty airplane engines.

Steels with 4 to 6 per cent chromium, generally with 0.50 per cent molybdenum, are used for cracking or handling hot oil and superheated steam. Corrosion resistance of these steels, taken in conjunction with their economics, dictates their choice even though this corrosion resistance is not of the same order of magnitude as that of stainless steels.

In Cast Iron

In the development of the modern cast irons, chromium has found a leading place. Additions are made either as alloy to the ladle or through briquets melted with the charge in the cupola. Even such a small amount as 0.25 per cent Cr begins to stabilize the structure of the iron, whereas increasing amounts, up to 1 per cent or more, raise the strength without unduly affecting machinability, increase the wear resistance, and very markedly reduce the tendency of irons to grow on repeated heating and cooling. Still greater percentages, while noticeably increasing the brittleness of the iron, so improve resistance to oxidation that they find wide use in parts of furnaces, automatic stokers, and similar applications.

Among the non-ferrous uses of chromium, the increased use and improved performance of nickel-chromium electrical resistance wires in both home appliances and industrial furnaces are notable. Recently an iron base resistance wire, containing about 35 per cent of chromium with 8 per cent of aluminum, has come on the market. It is finding its place in industrial furnaces run at high temperatures, such as those used for heat treating high-speed steels. Likewise, the advent of Inconel, a 15 per cent chromium, high nickel alloy, and the efficacy of chromium in high conductivity, high strength copper alloys point to increasing usage in the non-ferrous field.

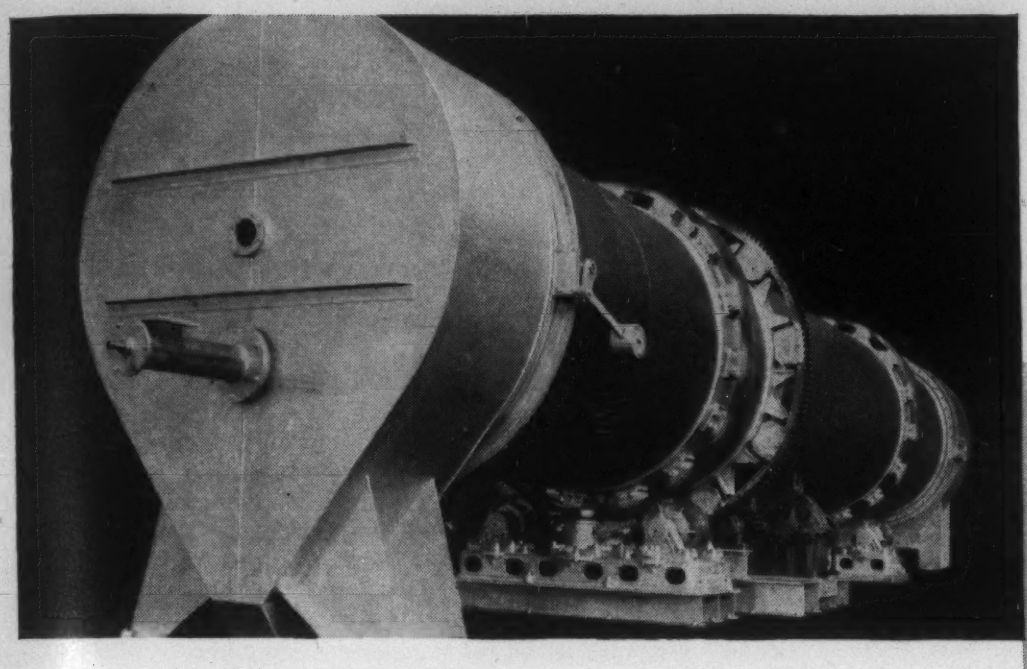
In Stainless Steels

The rapid and continuous growth of stainless steel in the last 10 years, often in opposition to the trend for general steel production, is most striking. Basically, stainless steels derive their "stainlessness" from the 12 per cent or more of chromium which they contain. During the decade knowledge of the properties has increased the application of these steels, and better technique in manufacture has resulted in markedly improved quality. Modification of older analyses has been a further important factor.

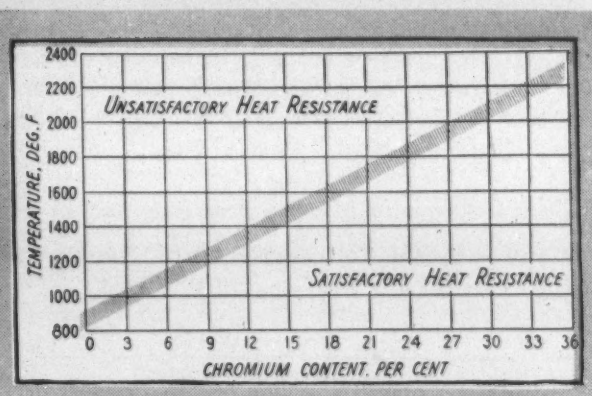
For example, stainless cutlery steel now carries higher chromium and carbon, with or without molybdenum, for improved edge-holding properties. Stainless engineering steels, especially those designed for the more exacting uses, carry 16 to 18 instead of 12 to 14 per cent chromium. Addition of a little nickel to a 16 per cent chromium steel makes it respond to heat treatment so

ON HOT JOBS . . .

Chromium Safeguards Equipment Investment

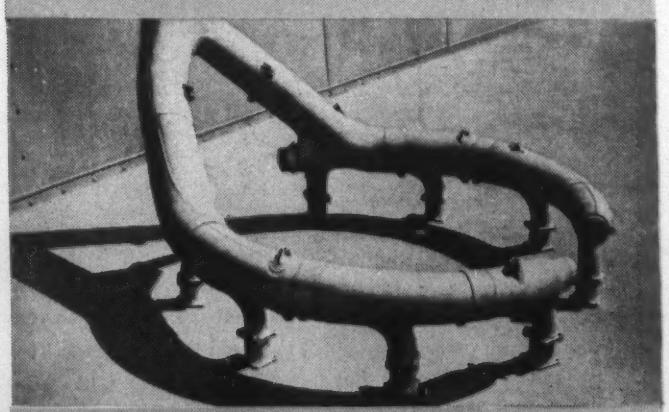


This giant rotary kiln is fabricated from 27,800 pounds of 25-12 chromium-nickel steel to resist the heat of high-temperature processes. The curve below shows the relationship between chromium content and temperature, based on chromium steels found satisfactory in service.

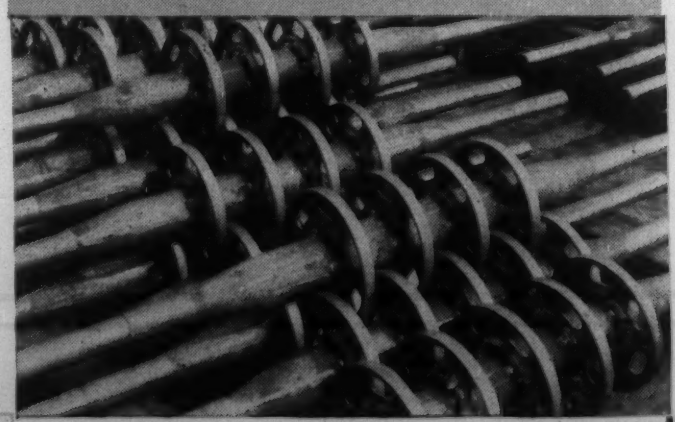


CHROMIUM-ALLOYED iron and steel can stave off the oxidation that blasts equipment investments where high temperatures are encountered. Chromium iron stoker links can wade continuously through raging furnace temperatures and remain in satisfactory condition many times longer than iron without chromium. In roasting kilns, it is chromium steels that last against the effects of searing temperatures. Vital performance of aircraft engines is safeguarded by chromium steel exhaust valves and manifolds where the flaming heat of burned gases would make short work of ordinary steel. Even in the inferno of annealing furnaces, high-chromium steels give long service.

We do not make iron or steel—but if you do—or if you fabricate or use equipment subject to high temperatures or other conditions where ordinary steels will not serve—"Electromet" offers without obligation unbiased metallurgical data and assistance in solving your alloy problems.



The chromium content of the steel used in the aircraft collector ring above and the pack heating furnace shafts below makes them resist the extremely high temperatures encountered in service.



At the Show—You can learn more about chromium and how it imparts heat resistance and other valuable properties to iron and steel at the Electromet exhibit, Area L305, National Metal Exposition, International Amphitheatre, Chicago, October 23-27, 1939. Plan now to attend and bring your questions.

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that it becomes particularly useful in airplane struts. Oxidation resistant steels of 20 to 30 per cent chromium are toughened by the use of nitrogen. Each of these improvements has resulted in better over-all economy.

"18 and 8"

The most popular of the stainless steels is the austenitic 18 per cent Cr-8 per cent Ni variety. In the past decade many important modifications have been made to permit steels of this category to meet more severe conditions. The increase of alloy content to 25 per cent chromium and 12 per cent nickel is typical. The addition of titanium or columbium to maintain ductility and corrosion resistance after the steel is subjected to elevated temperatures is another important development. Increasing hot workability by higher manganese, and increasing corrosion resistance, particularly the pitting and contact type, by the addition of molybdenum are further illustrative and account in no small part for the constantly growing use of the austenitic stainless steels.

The combination of corrosion resistance, very high strength and ductility, and weldability of cold rolled austenitic stainless steels has made possible the modern light-weight structures typified by the stainless steel trains and truck bodies, where decrease in weight produces revenue.

With continually wider use, knowledge of the valuable properties of stainless steels becomes spread and the demand thereby increased, so that it is safe to look ahead to their continued rapid growth for a number of years to come.

A Related Article in METALS AND ALLOYS

"Non-Rusting and Heat Resisting 34% Chromium Alloy Cast Irons," by E. Houdremont & R. Wasmuht—Feb., 1933.

Molybdenum

by A. J. Herzig
Chief Metallurgist, Climax Molybdenum Co.

Nothing can give a better idea of the progress of molybdenum as an alloying element for iron and steel during the past 10 years than a comparison of the world consumption figures for 1929 and 1938. In 1929 the world consumption was about 3,000,000 lbs. as compared to a consumption of about 28,000,000 lbs. in 1938. These figures are particularly illuminating in view of the fact that world steel production was 118,300,000 gross tons in 1929 and about 105,850,000 gross tons in 1938.

The situation in certain industries offers interesting side lights on the progress of molybdenum steels. For example, in 1929 there were only three recognized SAE types. Today, there are four, comprising 13 individual steels. Also, in 1929 only a few automobile manufacturers were using molybdenum steels at all. All major automobile manufacturers are now standardized on molybdenum steels for a number of highly stressed parts, and one uses them wherever alloy steels are required.

In the Oil Industry

The use of molybdenum steels for oil drilling equipment has increased from practically nothing in 1929 to an almost universal use today. A combination demand for stronger materials and better drilling economy in deep drilling has led to the use of molybdenum steels of various types in practically every kind of drilling and pumping equipment.

The same extension in use has taken place in oil refining. In 1929 little was known about the creep strength of steel at elevated temperatures, and there was less necessity for the knowledge. Continual increase in operating temperatures and pressures made good creep properties essential and led to the development of several molybdenum steels particularly adapted to refinery work. Today these steels are standard. Much the same situation has resulted in the standardization of carbon-molybdenum steel for steam generating equipment.

In Stainless and High-Speed Steels

The period between 1929 and 1939 has already seen considerable progress in the addition of molybdenum to the stainless, or corrosion-resisting steels of the "18 and 8" variety.

High-speed steels containing molybdenum first appeared in 1932. Since then much work has been done in the molybdenum-tungsten grade in developing improved types, and several are now available. Molybdenum in amounts up to 1 per cent is also being added to standard tungsten high speed steels.

Molybdenum steels have become widely adopted in aircraft construction during the past decade. Chromium-molybdenum steel (SAE X4130) is practically standard for certain structural members and parts. Molybdenum nitriding steels and various SAE molybdenum steels are extensively used for engine parts.

Much the same situation with regard to molybdenum steels exists in many other industries. The steels have become thoroughly established for a great number of applications in the last 10 years. It is particularly worth noting that these "newer" steels are replacing steels that were formerly firmly established with a coincidental saving in cost and improvement in quality.

In Cast Iron

As to cast iron, molybdenum cast iron was practically nonexistent in 1929. In fact that is just about the period of the first intensive experimental work on molybdenum irons. To sum up what has been done in the ten year period, today the production of molybdenum irons of tensile strengths between 60,000 and 80,000 lbs. per sq. in. is perfectly practical. A great deal of progress has also been made in the development of molybdenum irons having high strength in heavy sections. Thanks to these developments the field for molybdenum irons has extended to include many varieties of industrial equipment.

The work of investigating the fundamental effects of molybdenum on ferrous alloys has paralleled the progress in application. To take only one instance, the study of the effect of molybdenum on the transformation rate of steel has produced data of decidedly practical interest to users of steel.

Some Related Articles in METALS AND ALLOYS

"Mechanical and Creep Properties of Mo Cast Iron," by C. H. Lorig & F. B. Dahle—Oct., 1931.
"Molybdenum—Today and Tomorrow," by J. L. Gregg & H. W. Gillett—Apr., 1932.
"Microstructures of Mo-Max and 18-4-1," by R. G. Kennedy, Jr.—Oct., 1937.

Nickel and Its Alloys

by Thos. H. Wickenden
Assistant Manager, Devel. and Res. Div., International Nickel Co., Inc., New York

The first article in the first issue of METALS AND ALLOYS—except for the editor's introductory remarks—was entitled: "Two Decades of Precipitation Hardening Alloys," by Zay Jeffries. The past decade has seen the principles involved extended to many alloy combinations and among these the nickel-containing alloys have played a prominent part indeed, extending over a wide range of nickel contents from the nickel-tin age-hardening bronze to the age-hardening of nickel itself by the addition of such elements as titanium or beryllium, and in the intermediate ranges of nickel and copper we find small quantities of silicon and aluminum—either separately or together—utilized to promote this strengthening and hardening effect.

High Nickel Alloys

A number of new and interesting high nickel-containing alloys, generally with chromium and/or molybdenum, have been developed in the heat and corrosion-resistance field but the alloys of 10 years ago—with some refinements—constitute the bulk of material used in commercial applications today. The electrical resistance alloys are a typical example where the basic compositions remain the same but by refinement in manufacture and deoxidation their service life has been increased on the order of four or five fold; minute additions of calcium, cerium, thorium, zirconium and aluminum have contributed to this improvement. New information on high temperature properties of cast and

wrought heat-resisting alloys together with better engineering utilization of these data have contributed much to their advancement and widening field of use. The thermostatic alloys have extended their range of usefulness and have enjoyed a broad expansion in diversified fields.

Metallic Nickel and Nickel Plating

Wrought and cast metallic nickel is much more widely used today than was the case a decade ago, being used in a variety of applications and industries. While the use of nickel was well established at the beginning of the period for coinage purposes, the number of governments adopting it has increased at least 50 per cent and the type of coins placed in circulation has doubled. The acceptance of nickel coinage by the South American countries has been quite pronounced. In the construction of tubes for radio, X-ray, cathode ray and various electronic applications nickel is being used in substantial quantities for plates, grids, screens, cathodes, etc. The chemical industry accounts for the largest tonnage use, in many cases as commercially pure nickel tubes, plates and shapes, but the introduction of nickel-clad steel during this period has stimulated its use in the construction of equipment of various kinds—the caustic industry being one of the principal users but also finding application in the rayon industry and the manufacture of synthetic resins and plastics. Important developments in welding technique, welding rods and coatings for nickel and its various alloys have been a big factor in its growth, as equipment in contact with corrosive material can be made to present continuous corrosion-resistant surfaces.

In the nickel plating field far reaching developments have taken place. The commercial acceptance of bright nickel plate has been outstanding; less spectacular but of great importance has been the increasing demand for heavier nickel plate not only in parts exposed to atmospheric corrosion which are generally finished by a flash of chromium, but in some heat and corrosion resisting applications and in the rebuilding of under-sized parts—the latter has been stimulated by recently published information on heavy deposits and hard nickel plating. A recent development may extend the use of nickel plate much further for application under mild and intermediate corrosive conditions. In the process the nickel plated surface is reported to have an impervious coat with remarkable resistance to salt spray and other corrosive conditions.

Powdered nickel has become readily available during this period and is rapidly finding many uses in powdered metallurgy. It is being used in paints both for its decorative effect as well as its corrosion resistance; also a nickel ink is available for printing.

While high permeability nickel-iron alloys have increased in use, the outstanding development in the magnetic field has been the introduction of the aluminum-nickel-cobalt type of permanent magnets which have such high magnetic strength and permanence that they are finding wide application in radio speakers, high tension magnetos, watt-hour meters, direct current instruments, and in small and medium size motors. In addition, these magnets are being used in magnetic chucks, magnetic separators, and magnetic filters for removal of iron particles from lubricating oil. While most of the alloy is produced by casting, the technique of manufacturing by pressing and heating metal powders has been commercially introduced which permits the making of small and accurately shaped permanent magnets.

The use of nickel in brass, bronze and nickel silver has shown noticeable expansion, extending from the use of small quantities in red brass to refine the grain and improve its pressure-tightness, to the increased use of nickel-silver in architecture, for plumbing and decorative purposes. The wide acceptance of 70/30 copper-nickel alloys for handling salt water—an old alloy but new information on its resistance to sea water corrosion and non-fouling characteristics, being toxic to marine growth—has led to its wide acceptance for salt water lines and condenser tubes, not only on ships but in refineries and chemical plants.

Some Related Articles in METALS AND ALLOYS

"Monel Metal Castings," by F. M. Chambers—July, 1930.
"Invar, Elinvar and Related Iron-nickel Alloys," by J. W. Sands—June, July, 1932.
"Engineering Properties of K-Monel"—Apr., 1935.
"Foundry Production of Nickel Silver," by T. E. Kihlgren—June, 1935.
"Temperature of Recrystallization of Nickel," by E. Fetz—Dec., 1937.
"Manufacture of Nickel-Chromium Resistance Wire," by D. Graf, G. Miller & F. P. Peters—Oct., 1938.
"Carbonized Nickel for Radio Tubes," by T. H. Briggs—Nov., 1938.

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Continuous Hot Strip and Plate Mills

by G. G. Beard
United Engineering & Foundry Co., Pittsburgh

Within the last 10 years there have been many outstanding developments in the fabrication of various steel products. Among the various advances made, the development in the art of rolling flat steel products by the continuous and semi-continuous processes is outstanding.

Actually the continuous strip mill was a development of a continuous sheet mill first installed by the American Rolling Mill Co. at its Ashland, Ky., plant in 1924, which was followed by the installation of a semi-continuous strip mill at the same company's plant at Butler, Pa., in 1926. However, it was not until the period 1929 to 1939 that a rapid increase in the number of such units took place due to increasing demands for sheet and strip steel products. The location of these continuous strip mills in the United States has, with a few exceptions, been confined to certain districts close to points of consumption and the products of those mills have been dictated to a large extent by the demands of local industries, as for example the automobile industry, which naturally favors the installation of such high-capacity single purpose mills.

During the period from Jan. 1, 1929, to date, the following mills have been installed in the United States:

Company	Width of Mill	Year Placed in Operation
Carnegie-Illinois Steel Corp.:		
Gary, Ind.	38-in. Continuous	1929
So. Chicago, Ind.	96-in. Continuous	1931
Youngstown, Ohio	43-in. Continuous	1935
Gary, Ind.	80-in. Continuous	1936
Homestead, Pa.	100-in. Semi-continuous	1937
Fairfield, Ala.	48-in. Semi-continuous	1937
Clairton, Pa.	80-in. Continuous	1938
Allegheny-Ludlum Steel Co., Brackenridge, Pa.	36-in. Continuous	1932
American Rolling Mill Co., Middletown, Ohio	80-in. Continuous	1929
Bethlehem Steel Corp., Lackawanna, N. Y.	79-in. Continuous	1935
Sparrows Point, Md.	56-in. Continuous	1937
Ford Motor Co., Dearborn, Mich.	66-in. Continuous	1935
Granite City Steel Co., Granite City, Ill	90-in. Semi-continuous	1937
Inland Steel Co., Indiana Harbor, Ind.	79-in. Continuous	1932
Indiana Harbor, Ind.	46-in. Continuous	1938
Jones & Laughlin Steel Corp., Pittsburgh	96-in. Continuous	1936
National Steel Corp., Ecorse, Mich.	38-in. Continuous	1930
Ecorse, Mich.	96-in. Continuous	1936
Otis Steel Co., Cleveland	77-in. Continuous	1932
Republic Steel Corp., Cleveland	98-in. Continuous	1937
Sharon Steel Corp., Sharon, Pa.	24-in. Continuous	1932
Wheeling Steel Corp., Steubenville, Ohio	60-in. Continuous	1929
Youngstown Sheet & Tube Co., Youngstown, Ohio	79-in. Continuous	1935

The following figures illustrate the total annual capacity in gross tons of all continuous and semi-continuous hot strip and plate mills in the United States as of December of each year for the past ten years:

Year	Annual Capacity in Gross Tons
1929	4,214,000
1930	4,749,000
1931	5,469,000
1932	7,069,000
1933	7,069,000
1934	7,069,000
1935	9,310,000
1936	11,510,000
1937	14,504,000
1938	15,644,000
1939 (August)	15,644,000

From the above figures, the period of inactivity between 1932 and 1935 will be noted, due to the adverse economic conditions existing at that time. It is also interesting to note that in the three-year period from January, 1935, to December, 1937, the capacity of hot strip and plate mills was doubled.

Due to the fact that the leading steel corporations are now in general well equipped for the present and probable future demand for flat rolled steel products, we cannot look to any appreciable increase in strip mill equipment within the next 10-year period comparable with the outstanding increase which has taken place within the past decade.

So far as the mills themselves are concerned progress in their construction has been marked by an increase in mill speeds with corresponding increase in motive power, heavier construction and the utilization of more and more auxiliary equipment for the production of a better product.

Some Related Articles in METALS AND ALLOYS

"Securing Quality in Steel Plate," by J. S. Huston—Oct., 1931.
"Probability in Tin Plate Practice," by C. B. Post—May, 1934.
"Flood Lubricated Sleeve Bearings for Rolling Mills," by F. P. Peters June, 1939.

Metals and Alloys at High Temperatures

by N. L. Mochel
Metallurgical Engineer, Westinghouse Electric and Mfg. Co.

It is quite impossible to review in the space of a few hundred words that which has taken place during the past 10 years in the application of metals and alloys at high temperatures. The term "high temperature" is a relative one. A comparatively small increase in temperature above the normal introduces the same high temperature considerations in the application of some metals and alloys as does the increase of many hundreds of degrees in the application of others. High temperature considerations vary widely in different applications and industries. Characteristics important to one mean little to another. One may require information as to creep rates for one application one-one-hundredth or one-one-thousandth as great as for another. One may be interested in some cases in a life of 20 or more years; others a life of a few months. Total deformation is a vital consideration in some cases; in others it is relatively unimportant. This widely varying nature of the high temperature problem has been more and more appreciated in recent years. With this has come the realization that much available high temperature data is of doubtful value to some industries, although quite usable to others.

Early Symposiums

In this country, sufficient interest had been aroused by 1924 as to justify a symposium, jointly sponsored by the American Society for Testing Materials and the American Society of Mechanical Engineers. As a result the Joint Research Committee on Effect of Temperature on the Properties of Metals was formed the next year, and this Committee has taken the leading part in the years since that time in the field indicated by its name. A more or less periodic taking stock of what we have, what we need, where are we going, is very necessary in most fields of activity. Early in the 10-year period under review, in 1931, it was considered desirable to hold a second symposium, to thoroughly consider the needs of the various industries, and to take stock of available materials and data.

To meet a growing cry for creep data, the Committee collected all available test data on the subject, both in this country and abroad, and this collection of data, 848 pages in all, was published in 1938. Despite the 848 pages, this publication indirectly showed how very poor we are as regards reliable data on many materials in active use.

The Creep Test

Despite the many objections to its use, despite the expense and time and difficulties involved in carrying out reliable creep tests, this test continues to be one of the most important considerations in the application of metals at high temperatures. Methods of test are still considered as tentative. The Howe Memorial Lecture of the A.I.M.E. in 1939, by Gillett, under the title "Some Things We Don't Know About the Creep of Metals" is a timely and constructive discussion that all interested in creep should carefully study.

A growing interest on the part of those primarily interested in applied mechanics and in physics has been and will continue to be of great help in the interpretation and use of creep data.

Creep Not the Only Consideration

The 10-year period has developed a better appreciation of the fact that creep is not the only high temperature consideration. Mat-

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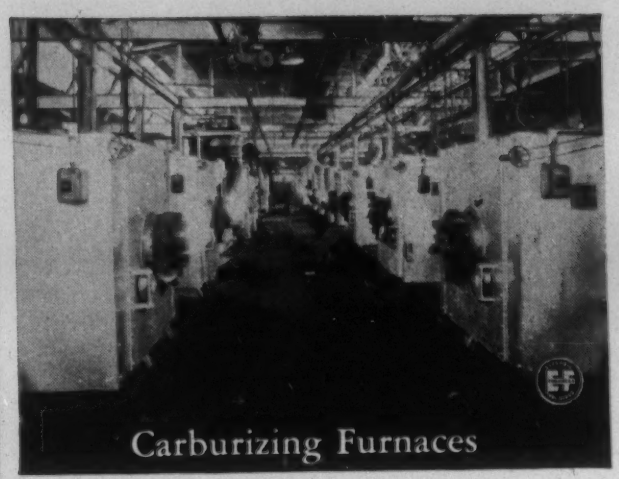
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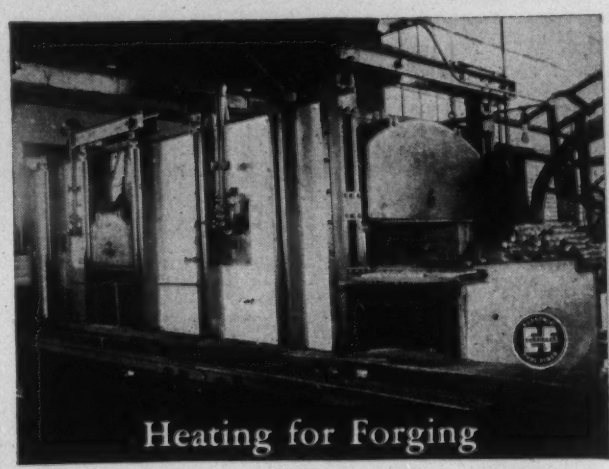
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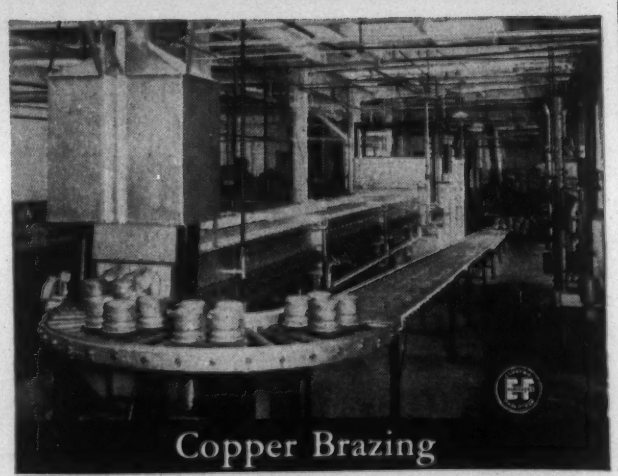
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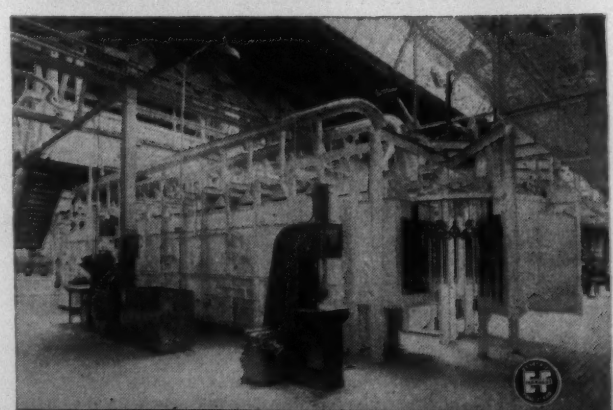
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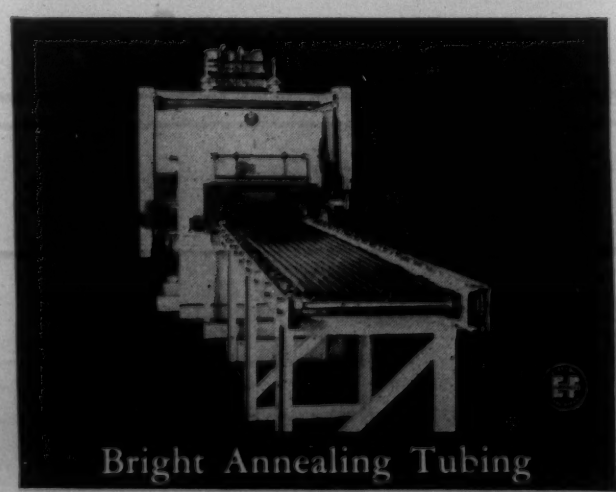
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ters of relaxation, combined stresses, stability, fatigue, embrittlement, and many others must receive equal consideration in many applications.

As stated before, creep tests are expensive, and require much time and they are difficult to carry out properly. There has been much seeking for a "shorter route to India," and as is usual in such cases, some new discoveries have been made. The work of White and Clark in their time-to-rupture tests is one such case, and better appreciation of the value of the relaxation test is another. There will be much further thought along these lines, the comparison of results from various shorter tests with those of the long-time creep tests. There will be several further considerations of fatigue at high temperatures.

Manufacturing Variables

The work of the Joint Research Committee on the effect of manufacturing variables on creep resistance certainly may be considered as the most important forward step in the 10-year period. The work has largely been carried out at Battelle. It is by no means finished, but it has already explained the wide differences in creep characteristics reported for supposedly similar steels. It has brought the realization that the creep test is perhaps the most sensitive test that we have yet applied to materials. It has definitely shown that analysis alone cannot guarantee desired creep properties, that variables of deoxidation practice, heat treatment, grain size, and alloy content all have a bearing on the behavior at high temperatures. This work is vitally important in the next item of this review.

The American Society for Testing Materials, especially through its Committee A-1 on Steel, as well as through A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys and B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys, has proceeded steadily on its way in the development of standards for materials for high temperature service. Standards for castings, forgings, pipe, tubing, plates for boilers, nuts, bolting, have already made their appearance. The work of the Joint Research Committee on manufacturing variables will permit of further improvements in these standards.

Non-Ferrous Materials

The need for better information on the effect of temperatures on non-ferrous materials has arisen and the Joint Research Committee is now "taking stock" in this field. Non-ferrous materials offer many advantages, such as corrosion resistance and thermal conductivity in many applications, but we appear to be very poor in our knowledge of their high temperature properties. The non-ferrous field will produce interesting and valuable information and materials in the future; as a matter of fact several comparatively new high nickel alloys show promise of better load-carrying ability at low red heats than available steels.

Some Related Articles in METALS AND ALLOYS

"Do You Need Better Alloys for High Temperature Service?" —Dec., 1930.

"Present Aspects of Materials for High-Temperature Service from the Creep Design Standpoint," by J. J. Kanter & L. W. Spring—Dec., 1930.

"Obtaining Reliable Values for Creep of Metals at High Temperatures," by H. W. Gillett & H. C. Cross—July, 1933.

"Properties of Aluminum and Two of its Alloys at Elevated Temperatures," by F. M. Howell & D. A. Paul—Aug., 1934.

"Properties of Wrought Aluminum Alloys at Elevated Temperature," by F. M. Howell & D. A. Paul—Oct., 1935.

"High Temperature Tests of Ni-Cr Alloys," by K. E. Quier—Feb., 1938.

"Mechanical Properties of Copper at Elevated Temperatures," by C. H. Lorig, F. B. Dahle & D. A. Roberts—Mar., 1938.

Metals and Alloys at Low Temperatures

by Francis B. Foley

Director of Research, The Midvale Company

The principal problem involved in the application of metals to service at sub-atmospheric temperatures is one of toughness. This is the opposite of the problem involved in elevated temperature service where, as a rule, the ductility of metals increases, flow sets in and strength becomes the matter of principal concern.

There are many instances in elevated temperature application of metals where ductility is low, metal breaks short without warning and both strength and ductility have to be studied. There are, however, no cases on record where metals subjected to low temperatures under stress have decreased in strength although ductility, particularly in ferrous alloys, is frequently lowered to the danger point. In the case of many non-ferrous metals, particularly the nickel and the copper base alloys, not only does strength increase with decrease in temperature but ductility, as measured by elongation in tension or by notched bar impact tests, is found also to increase.

In view of these general facts the study of the effect of sub-atmospheric temperature exposure on the properties of metals has centered in the convenient notched bar impact test.

Non-Ferrous Metals and Alloys

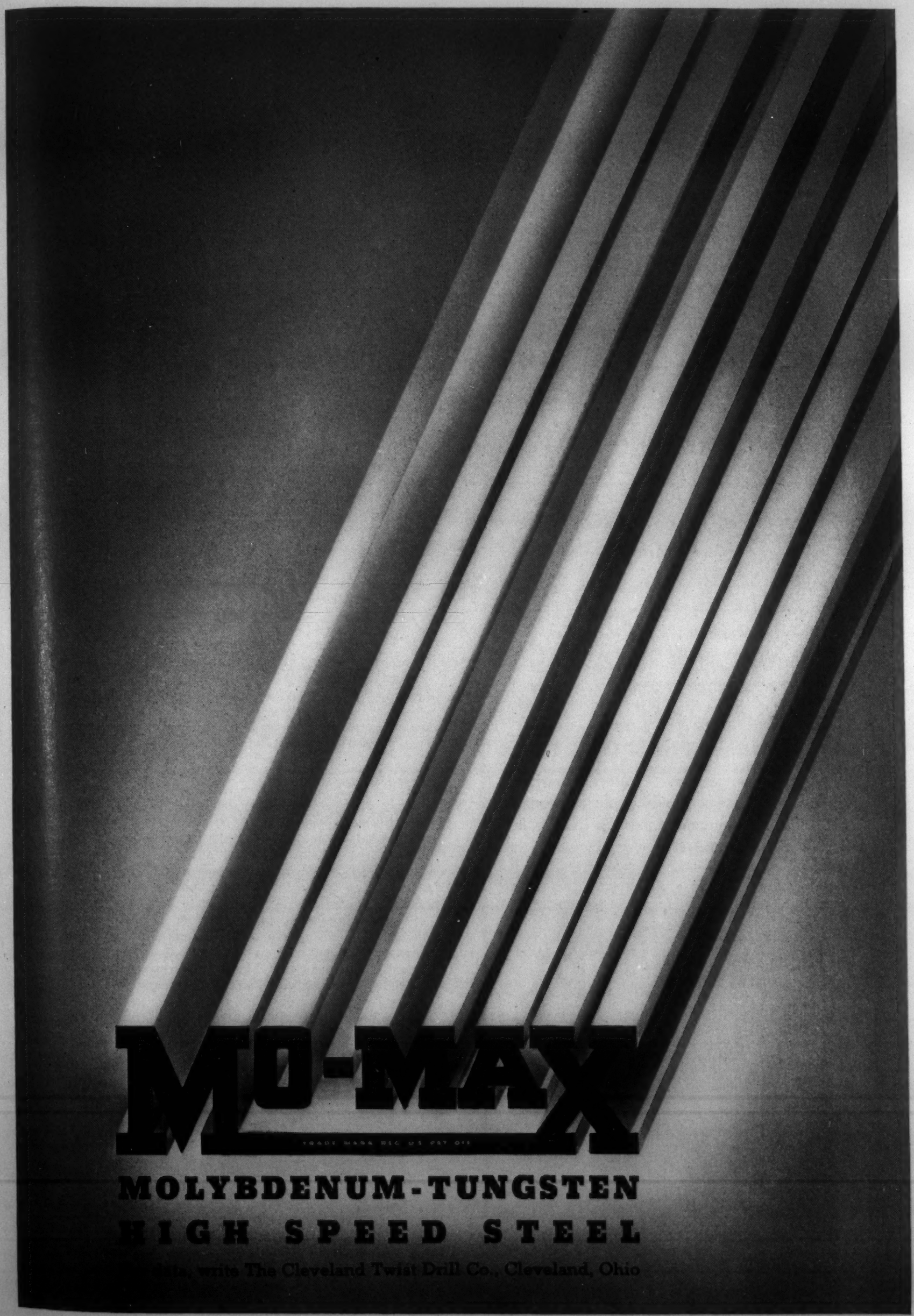
Charpy impact tests made on 45-deg. V-notched specimens of pure nickel show an increase in impact value from 135 ft. lbs at room temperature to 236 ft. lbs. at minus 112 deg. F. and 227 ft. lbs. at minus 310 deg. F. Cold drawing or annealing has little effect on these values. Monel metal, 69 per cent Ni-29 per cent Cu, when hot rolled, is only slightly affected by refrigeration, having a value of 219 ft. lbs. at normal temperature and 196 at minus 310 deg. F. Annealed Monel has about the same values as hot rolled metal but cold drawing lowers them somewhat to 161 ft. lbs. at room temperature falling off to possibly 122 ft. lbs. at minus 310 deg. The addition of 13 per cent Cr, 7 per cent Fe and some carbon to produce the alloy known as Inconel produces a metal having impact values about like those of Monel but cold drawing lowers the toughness of Inconel considerably to values of 33 or 40 ft. lbs. at room temperature and 28 to 33 ft. lbs. at minus 310 deg.

Pure copper behaves like pure nickel when tested at sub-atmospheric temperatures in that its strength increases at low temperatures and at the same time its ductility also increases, sometimes markedly. Pure copper, with a tensile strength at room temperature of 31,400 lbs. per sq. in., has a tensile of 58,000 lbs. at minus 292 deg. F. corresponding Izod values being 43 and 50 ft. lbs. Cupro-nickel, nickel-silver, 70-30 brass, manganese bronze, aluminum bronze, quenched copper-beryllium and Cu-Ni-Al alloys all maintain their toughness down to minus 292 deg. F. Aged copper-beryllium has a low Izod value, 2 ft. lbs., at room temperature with a tensile strength of 186,600 lbs. per sq. in. and gives 3 ft. lbs. at minus 292 deg. F. with a tensile strength of 214,000 lbs. per sq. in. The Cu-Ni-Al alloy has a tensile of 90,900 lbs. per sq. in. at room temperature with an Izod value of 40 ft. lbs. which is increased to 107,000 lbs. per sq. in. at minus 292 deg. F. with an Izod value of 55 ft. lbs.

Ferrous Metals and Alloys

Ferrous metals present a different picture. When iron is sufficiently alloyed to produce homogeneous stable austenite, it maintains good impact values down to liquid air temperatures and below. For example, when nickel of over 42 per cent is alloyed with iron, impact values are high at all sub-atmospheric temperatures at which tests have been run. A 60 per cent Ni-Fe alloy has a Charpy impact value at normal temperature of 47 ft. lbs. which increases to 61 ft. lbs at minus 300 deg. F. Austenitic 18 Cr-8 Ni had a Charpy value of 56 ft. lbs. at room temperature and 47 ft. lbs. when its temperature was reduced to minus 300 deg. F.

Low alloy steels and carbon steels present more of a problem than any of the metals so far mentioned. These ferritic steels, to differentiate them from the austenitic steels, are rendered tough at sub-atmospheric temperatures only by controlling the alloy content and by proper treatment. Tests of such steels show certain trends. Carbon seems to be detrimental to good low temperature toughness. Nickel and copper, which in the pure state have good toughness at very low temperatures, appear to be good alloying elements when added in proper amounts for preserving the toughness of ferritic steels at low temperatures. Manganese, molybdenum and vanadium, when added in proper amounts, appear also to aid in preserving the toughness of steels. Under ordinary circumstances ferritic steels can rarely be made to show very good toughness at temperatures much below minus 150 deg. F. but they can be made to show good toughness at that temperature. Ordinarily they have quite low values at liquid air temperatures.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write The Cleveland Twist Drill Co., Cleveland, Ohio

A steel of low carbon with 3 per cent Ni and 0.25 per cent Mo has found considerable favor for use at temperatures down to minus 150 deg. F. With a double normalizing and drawn at 1200 deg. F., it will have a Charpy value of 25 to 35 ft. lbs. at this temperature. In castings it has quite as good values as in forgings.

The factors conducive to toughness in steels at low temperatures appear to be: Low C content, proper alloy content, structural homogeneity and freedom from internal stresses. Some alloys appear to act as specific tougheners while other alloys appear to aid in producing necessary refinement of structure. Treatments which produce the finest and most homogeneous microstructure together with freedom from internal strain are essential requirements.

Some Related Articles in METALS AND ALLOYS

"Mechanical Properties at —40 deg. of Metals Used in Aircraft Construction," by J. B. Johnson & T. Oberg—Mar., 1933.

"Low Temperature Impact Tests of Medium Manganese Steel Plate," by H. W. Heimke & W. C. Schulte—Feb., 1934.

"Nickel Steels at Low Temperatures," by G. Aldridge & G. C. Shepherd, Jr.—June, July, 1936.

"Low Temperature Impact Properties of Some SAE Steels," by A. J. Herzig & R. M. Parke—Apr., 1938.

Endurance Limit Under Repeated Stress

by H. F. Moore
University of Illinois, Urbana, Ill.

The last 10 years study of the mechanism of "fatigue" of metals, especially by the aid of X-ray diffraction, has shown that under repeated stress there is a process of "fragmentation" in crystalline grains which does not necessarily mean a destructive spreading crack. At some unknown stage this fragmentation may start an actual fatigue crack. The slip planes on which fatigue cracks start, are found to be definite atomic planes within a crystal. Studies of effect of size of crystalline grains have indicated some advantage in small grains, but the amount is quite uncertain. Much more data has become available on the fatigue strength in non-ferrous metals.

Effect of Stress Raisers

The quantitative study of the effect of stress raisers has made considerable progress. The use of transparent models viewed by polarized light to determine the theoretical stress at a given stress raiser has come into wide use, and the "plaster model" method has also been used. It has been found, that, owing to the slight inelastic strains which can be developed even in the brittlest of our metals, "peak" stresses are reduced, and actual stress concentration is not as severe as theory calls for, and so far it has always been less severe than the stress concentration indicated by the photoelastic or the plaster model methods. In general, high strength steels are always more sensitive to stress raisers than low strength steels, thereby partially reducing their advantage.

Little has been done on the sensitivity of non-ferrous metals to stress raisers. The fatigue strength of large specimens of some metals has been found to be distinctly less than that of small specimens. It has been found that surface conditions, stress raisers and size play so important a part in determining the strength of structural parts and machined members that the endurance limit determined from small polished specimens is not very reliable as a guide for design. Full-size tests of machine and structural parts are becoming more and more important. Such tests have been made on pressure vessels, railroad rails, bolts, car axles, structural joints, welded and riveted, and wire.

The structural engineer has become "fatigue minded." He has realized that in many parts, especially of a rigidly welded or riveted structure, there are repeated secondary stresses and while these secondary stresses may not be important under static conditions, under repeated loads they may start cracks, and the structural engineers have taken up studies of welds and riveted joints. For many structural parts the number of cycles of stress during a satisfactory "life" is measured by thousands rather than by millions, and the determination of endurance limit for a relatively small number of cycles is satisfactory.

Corrosion Fatigue

Study of corrosion-fatigue has continued to demonstrate the serious damage done by this phenomenon and a considerable study of chemical inhibitors and protective coatings has been made. The question of the combined effect of corrosion-fatigue and stress raisers has been studied and it has been found that the additive effect of these combined actions varies widely in different metals.

From the viewpoint of our studies of stresses, strains and strength, the development of fatigue of metals has forced us to recognize that our common formulas are not rigidly true when applied to actual metals. They may be regarded as a very close "statistical" approximation when *ma*croscopic volumes of metal are involved. However, when we consider resistance to repeated stress a *mi*croscopic volume may be the nucleus of a spreading crack. At present we meet this situation by using our ordinary formulas and photoelastic or other mechanical determination of localized stress, and then modify the results by empirical "notch-sensitivity" factors for different metals.

Some Related Articles in METALS AND ALLOYS

"Effects of Surface Decarburization on Fatigue Properties of Steel," by C. R. Austin—Sept., 1931.

"Importance of Fatigue of Metals to Engineering Design," by T. A. Solberg & H. E. Haven—Sept., 1932.

"Fatigue and the Hardening of Steels," by H. J. French—Nov., 1933.

"How and When Does a Fatigue Crack Start?", by H. F. Moore—Nov. 1936.

"Improving Airplane Propellers by Surface Rolling," by G. Sachs—Jan., 1939.

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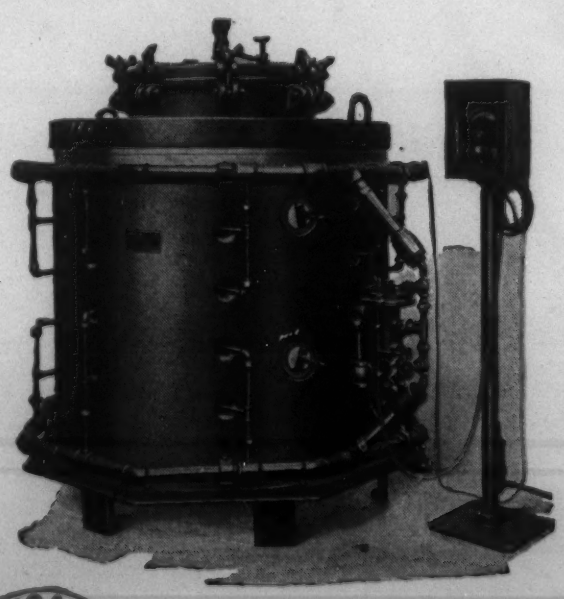

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By the Editorial Staff

Heat Treating and Controlled Atmospheres

by H. W. Gillett

Some drawbacks in heat treatment that were accepted as inevitable ten years ago may now be eliminated when it is economic to do so. Instead of making either an oxidized, or stained product, requiring pickling, or one with a decarburized bark, it is now possible to heat treat without injuring the surface. The principle of box-annealing with the introduction of a protective atmosphere has been greatly widened.

Instead of slow heating of a heavy box from the outside, electric resistors or radiant tubes supply the heat close to the work, and the gas atmosphere is chosen to suit the particular temperature and particular steel composition in question. At the low temperatures and with the low carbon steels common in the process annealing that is applied in the mill to a huge volume of sheets, an atmosphere of partly burnt fuel gas, without fussy purification, does a fairly good job.

Factors Which Are Fatal

But the annealing of high carbon steels, the normalizing of any steel, and particularly the heating of medium and high carbon steels for quenching, bring in conditions where moisture and CO_2 are fatal. In the early days this was not recognized by people who should have known better, and electric heat-treating furnaces were put on the market in which fuel gas and air were burned directly in the furnace chamber. The water vapor from the hydrogen in the fuel, thus directly introduced, did far more harm than occurs with no "protective gas."

These "gold brick" furnaces were soon stripped of their gadgets in the users' hands and operated without controlled atmospheres, but the need for clean hardening had to be met, so purification trains came into use by which water vapor was removed and only dry gas fed to the furnace. Then people slowly awakened to the fact that CO_2 is a bad actor, too, and further chemical purification was resorted to, to remove it. Finally, charcoal gas generators were put on the market which made gas higher in CO and lower in CO_2, so that the problem of CO_2 removal was minimized. The physico-chemical facts, that for a given temperature and given steel composition a certain $H_2 : H_2O$ ratio or $CO : CO_2$ ratio is required for the gas to be inert, and the further fact that H_2, or CH_4, and CO_2 will interact to produce H_2O, were finally yielded to as inevitable. Today, atmospheres of dry H_2 (from cracked NH_3); $CO + N_2$, and even almost pure N_2, are in wide commercial use, along with more complex, less pure, but cheaper, gas mixtures where the conditions are such that the impurities can be balanced, and the mixture thus made inert.

Bright annealing and clean hardening, without having to pickle off a heavy scale or to put up with a decarburized bark, are now realities.

In analogous fashion, the use of copper brazing in a reducing atmosphere has grown into industrial prominence, but it is still a shocking commentary on industrial backwardness that this cheap method of assembly remains neglected by many who might use it to great advantage.

Unsolved Problems

Protection in the soaking pit, and during forging or rolling, much more difficult of accomplishment, remain as unsolved problems, and there is still much to be done in the actual application of the protection of high-speed steel during hardening. An electrical resistor that will not be attacked by the various atmospheres necessary to protect different steels is also to be desired.

At low temperatures, as in tempering after hardening, where scaling is no problem, temperature uniformity, even in a closely packed charge, is accomplished by forced circulation of hot air. Stagnant atmosphere tempering furnaces are now obsolete, and modern furnaces make tempering almost a fool-proof process.

Temperature Uniformity

The problem of temperature uniformity at higher temperatures, where heat transfer is by radiation, is not yet solved in any fool-proof fashion. However, the campaign of education being embarked upon by the group of furnace makers, with the backing of the War Department, will help emphasize the importance of proper loading of furnace charges.

On the whole, the past decade in heat treatment has been marked by the commercial application of fundamental facts of chemistry and physics.

Some Related Articles in METALS AND ALLOYS

"*Industrial Heating for Heat Treatment,*" by R. M. Keeney—May, July, Oct., 1930; Jan., 1931.
"*Heat Treatment of Al Alloys,*" by R. J. Anderson—Sept., 1930.
"*Nitriding for the Engineer,*" by O. E. Harder—Sept., 1931.
"*Continuous Gas Carburizing in Practice,*" by E. A. Thomas—Apr., 1932.
"*Nitriding Plant and Technique,*" by H. H. Ashdown—Oct., 1932.
"*Heat-Treating Furnace Atmospheres,*" by S. Tour—Dec., 1932.
"*Heat Resisting Cr-Ni-Fe Alloys for Furnace Construction,*" by L. J. Stanbery—Oct., 1933.
"*Controlled Atmospheres in Steel Treating,*" A Correlated Abstract, by H. W. Gillett—Aug., Sept., Oct., Nov., 1935.
"*New Electric Process for Cyanide and Activated Baths,*" by E. F. Davis—June, 1936.
"*Hardening Razor Blade Steel by a New Process,*" by A. R. Stargardter—Oct., 1936.
"*Process and Result of Austenite Transformation at Constant Temperature,*"—Jan., 1937.
"*Controlling a Controlled Atmosphere,*" by A. E. Krogh—Feb., Mar., 1937.
"*Two New Applications of Induction Heating,*" by E. F. Cone—May, 1937.
"*Gases for Controlled Atmospheres,*" by E. E. Slowter & B. W. Gonser—June, July, 1937; Feb., Mar., 1938.
"*Atmosphere for Annealing Copper,*" by H. D. Holler—June, 1937.
"*Annealing Copper with Electric Heat,*" by E. K. Hansen & P. H. Brace—Aug., 1937.
"*Direct Electric Resistance Heating of Steel,*" by F. P. Peters—Oct., 1937.
"*Crankshafts and Other Parts Surface-Hardened by Inductive Heat,*" by E. F. Cone—Jan., 1938.
"*An Internally-Heated Electric Salt Bath Furnace,*" by F. P. Peters—Aug., 1938.
"*Cycle Annealing in a Two-Deck Furnace,*" by J. B. Nealey—Aug., 1938.
"*Continuous Box Carburizing,*" by R. H. Weber—Oct., 1938.
"*Gas Carburizing with Pure Propane,*" by F. P. Peters & M. G. Farrar—Jan., 1939.
"*Industrial Application of Austempering,*" by E. E. Legge—Aug., 1939.

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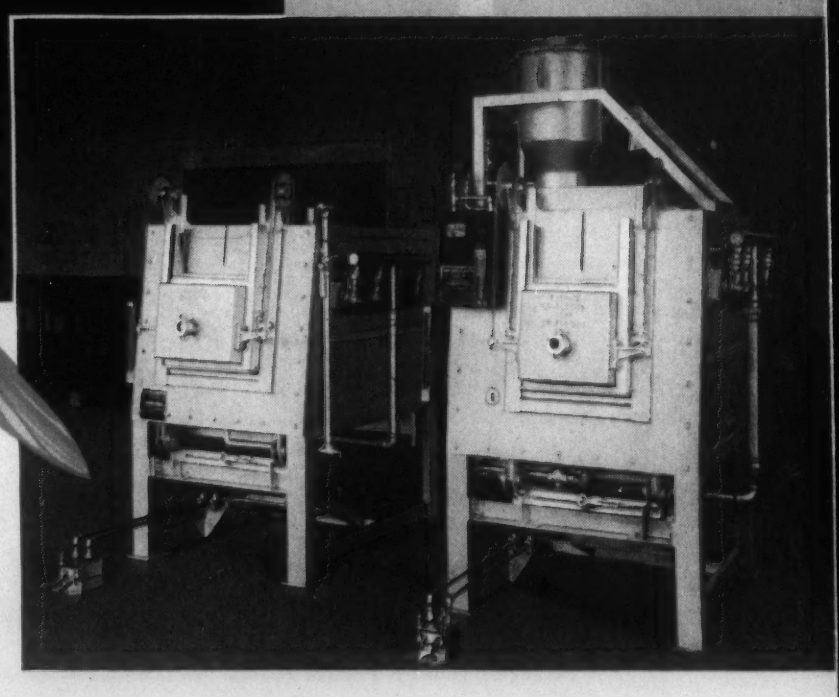

The Char-Mo furnace is available in both the preheat and superheat type as shown above. The atmosphere gas is generated in a self-contained generator which forms an integral part of the superheat furnace. The preheat furnace is supplied with atmosphere gas from the generator in the superheat furnace . . . In addition to the horizontal muffle type furnace as shown, the Char-Mo furnace is also available in a vertical muffle or pit type.

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Powder Metallurgy

by Fred P. Peters

Powder metallurgy is not the brand new art that the tremendous interest currently displayed in it might suggest. By 1929 the use of powder practice to prepare ductile tungsten, tantalum and other high-melting metals had become an old, familiar story; industry had already been introduced to the possibilities in the extra-hard cemented carbides for tool and die materials, made by pressing and sintering high-melting carbide and low-melting cobalt powders; the use of metal powders for paint pigments, for calorizing and similar metal-coating operations, for magnesium flares, for metal spraying, etc., was well established.

The last decade, however, has witnessed an ever-accelerating application of metal powder technique to the production of such industrial products as bearings, welding electrodes, electrical contacts, permanent magnets, magnetic cores, wear-resistant facings, dynamo brushes, dental inserts, medallions, etc. This review will concern itself largely with this fastest growing phase—the manufacture of industrial products by compacting metal powders—to which some writers would even confine the full meaning of the term "powder metallurgy" itself.

In Bearings

Great impetus was given to the application of powder metallurgy by the need for better bearings for the automotive industry. Copper-lead "alloys" and leaded bronze bearings were among the first to be made by powder practice. Almost simultaneously came the development of the now-familiar graphitic bronze and the porous "oil-less" bearing. These are made by pressing and heat treating (sintering) mixtures of copper, tin and graphite powders to produce a uniformly interlaced porous mass which is later impregnated with oil; in operation the oil seeps regularly from the body of the bearing by capillary action to the bearing surface, providing automatic lubrication.

Porous bearings are now being made from materials other than bronzes. Light metal bearings made by conventional metallurgy are growing in use in Germany, and it seems likely that powder practice may provide a means for improving and controlling the anti-friction and other properties of aluminum alloy bearings, provided methods of reducing the oxide content of aluminum powder mixtures can be developed. The use of bearings compacted from iron powders is already growing rapidly, although it still is hampered by the lack of a large supply of high quality, cheap iron powder.

Powdered Iron

In fact, there has been considerable recent activity in adapting "iron" of various sorts to powder practice. Carbonyl-iron powder is the basis of highly pure iron compacts that are widely used for magnetic cores in electrical, radio and television equipment. A British cast iron powder ("Pacteron") is being hot-pressed to make small bearings and non-porous gears that are said to have a tensile strength of 80,000 lbs. per sq. in. The new permanent magnet materials, *e.g.* of the Alnico type, are also often prepared by powder processes. One recently announced German development is the dispersion of ferromagnetic powders in molten low-melting non-magnetic materials; the powders are forced by an external field into positions they retain after solidification of the matrix, thus giving compacts of controllable directional magnetic or electrical properties. More than one laboratory is today working on the problem of making steel products by powder metallurgy.

With respect to raw material powders in general, refinements in manufacturing operations and particularly in the quality and purity of the powders have been steady though unspectacular. As previously mentioned, what this country still needs is a good 5-cent iron powder. The recent development of the hydride process, described in these pages, provides a supply of powdered hydrides that under suitable and simple conditions can be induced to release their hydrogen to leave a very pure, reactive metal powder available for alloying. Currently there is also much interest in the preparation of alloy powders, a field that will probably be intensely developed in the future.

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Technique in Powder Compacts

The general techniques employed for making powder compacts have developed along logical lines. The traditional low-temperature pressing followed by high temperature sintering is still most widely used, because it is easiest on dies and also because it is the most convenient method of producing porous products. Hot compressing—simultaneous pressing and sintering—is, however, receiving increasing attention for the production of non-porous compacts, for it offers definite sizing advantages and often much better ultimate physical properties than can be obtained by the sequential treatment.

A special kind of hot compressing, liquid-phase bonding—or, as W. D. Jones calls it, "fritting"—sems to be due for a vigorous revival in interest. This technique, long applied to the cemented carbide tool materials has been adapted by Smithells and his associates in England to the production of a sintered tungsten-copper-nickel alloy from powder mixtures containing 5 per cent Ni and 2 per cent Cu. A very dense non-porous structure consisting of tungsten bonded with a Ni-Cu-W alloy is achieved by hot pressing in a neutral atmosphere at 1400 deg. C. (at which the nickel and copper are liquid) and 5 tons per sq. in. for 1 hr. The sintered alloy, developed for radium containers, has already found other important applications.

Apparatus

The most important advances in compacting equipment have been in apparatus for heat treating and pressing. Special high frequency induction and electrical resistance heaters providing facilities for atmosphere or vacuum control have been developed. Recently hydraulic presses have been built that avoid previous slipping and air-trap difficulties through the incorporation of a double reservoir, which permits a very rapid stroke—about 20-30 cycles per min. Also, modern presses and dies are so designed that previously objectionable percentage density differentials are reduced to harmless levels. The speed at which future processing advances are made will depend in large part on the development of presses and dies capable of producing larger compacts to even finer dimensional tolerances than the present 0.001 in., and able also to withstand the much severer operating conditions encountered in hot compressing.

Some Related Articles in METALS AND ALLOYS

"Copper Lead Bearings from Metal Powder," by E. Fetz—Sept., 1937.
"The Hydride Process," by P. P. Alexander—Sept., 1937; Feb., July, Oct., 1938.
"Symposium on Powder Metallurgy," by F. P. Peters—Mar., 1938.
"Possibilities of High Pressures in Powder Metallurgy," by W. D. Jones—May, 1938.

Some Other Major Developments

by Edwin F. Cone

The foregoing array of discussions include many of the chief fields in the metal and alloy industry but there are numerous others which it has not been possible to include. Several of the latter could have been very ably discussed by competent men. In the following paragraphs, however, an attempt is made to very briefly call attention to a few developments in certain fields, not included in the other reviews. At best these must be sketchily treated.

The Blast Furnace

We are indebted to Prof. T. L. Joseph of the University of Minnesota for the following résumé of important developments:

1. Improvements in gas washing which have provided cleaner gas. 2. Improvements in the concentration of Eastern magnetites and wider use of sinter produced from such concentrates. 3. Lower sulphur specifications for pig iron has stimulated the use of soda ash in the runner and ladles. 4. Wider use of automatic stock line recorders and greater attention to proper distribution of the charge. 5. Technique for operating on slack wind, banking and fanning furnaces. 6. Emphasis on quality or uniformity and less on tonnage records. 7. New pig machines, higher capacity and lower cost. 8. Small pigs or piglets. 9. Daily capacity of most of the recent furnaces about 1,000 tons.

The Bessemer Convertor

Space permits only mention of the announcement of the Jones & Laughlin Steel Corp. of control of the Bessemer convertor by photo-electric cells insuring flame regulation and better steel.

Titanium

Extensive have been the applications of titanium in the metallurgy of steel, iron, and non-ferrous alloys in the decade. According to a leading producer of titanium and its alloys, some of these are as follows:

In steel—the most important has been its use in stainless to prevent intercrystalline corrosion and embrittlement. A similar effect has been utilized more recently in plain chromium steels (about 5% Cr) for decreasing the hardening after rapid cooling as in welding. A recent development is its use in the low-alloy, high strength steels to improve welding and so on.

In gray iron—the influence of titanium is now better understood; finer graphite can be produced.

In non-ferrous alloys—one of the largest uses is in aluminum alloys where it has a useful grain-refining effect. It is introduced as a master alloy of Ti and Al or "titanium hardener." The manufacture by hydride reduction and other methods of a pure cupro-titanium alloy for use in high-conductivity copper is noted. Titanium in nickel alloy welds to improve ductility is cited.

Phosphorus

Ten years ago phosphorus in steel was considered in an entirely different light from the present. The new use that is outstanding is in the low-alloy, high strength steels—to raise the tensile and yield strengths and to enhance atmospheric corrosion. Steel, with 0.10 to 0.15 per cent P, has a relative life, based on a given loss from corrosion in atmosphere, of the order of two to three times that of a similar steel with normal phosphorus content. It is one of the few elements which increases the yield strength of steel at a greater rate than the tensile strength—advantageous in the low-alloy, high strength steels.

Some other interesting applications of phosphorus in steel (also from a communication from Dr. C. H. Lorig of Battelle Memorial Institute) include the following: Phosphorus improves the tensile properties of steel at moderately elevated temperatures. This fact led to the discovery that phosphorus could be utilized in enameling sheet to improve sag resistance. This has been demonstrated by one large steel company; it also improves the adherence in enameling.

Other citations include: Phosphorus added to structural rail steel is claimed to be beneficial as to wear resistance, weldability, machinability and corrosion resistance. A Japanese investigator claims that phosphorus benefits the properties of magnetic alloys as to permeability and hysteresis loss.

In non-ferrous metals—its use as a deoxidizer has developed. Small amounts of phosphorus in zinc galvanizing baths, added as a P-Sn alloy, gives the zinc coating a better luster with superior adherence and ductility.

In phosphate coatings on steel distinct progress has been made.

Beryllium

Ten years ago very little was heard of the metallurgical uses of beryllium. Today it is expanding as an alloy with copper, both as castings and as a wrought product. This has been its widest application. Not much has been developed in the alloys of nickel and beryllium though rumors are plentiful concerning German uses. An authority tells us that he thinks that the beryllium-aluminum alloys have the brightest future. That it is a precipitation hardening alloy is a distinct advantage.

As a constituent in certain alloy steels, the future will no doubt witness considerable progress.

Lead

The outstanding metallurgical development in lead has been its introduction into open-hearth steel to produce a free-machining lead-bearing steel, "Ledloy." This has been quite fully discussed in several technical articles.

Large quantities of lead alloyed with less than 0.10 per cent Te are being used particularly as sheet and pipe in equipment in the

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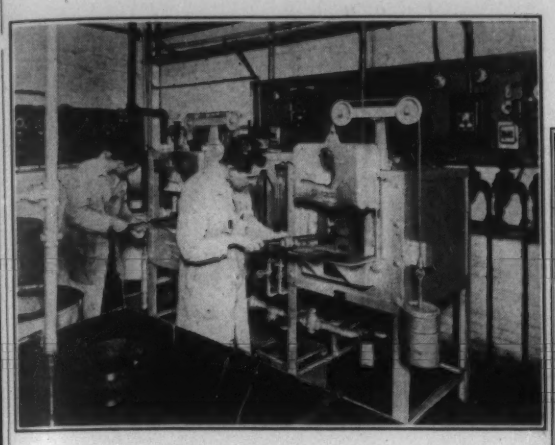

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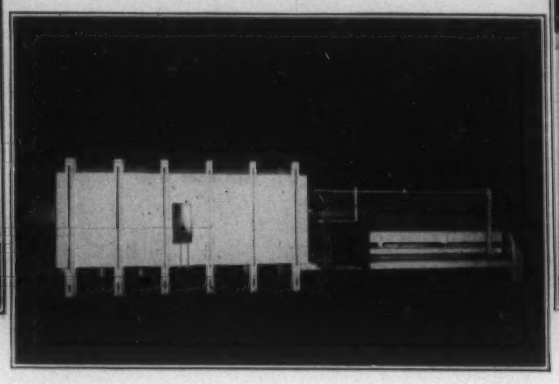

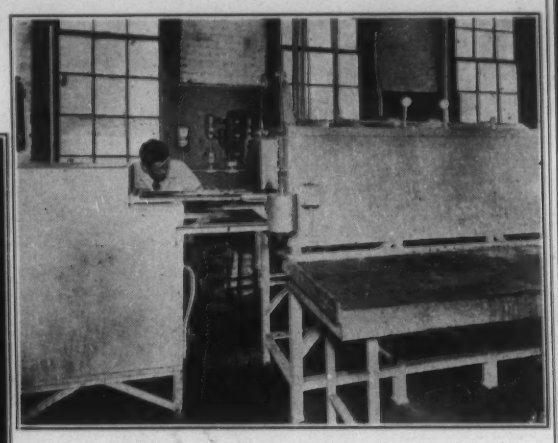

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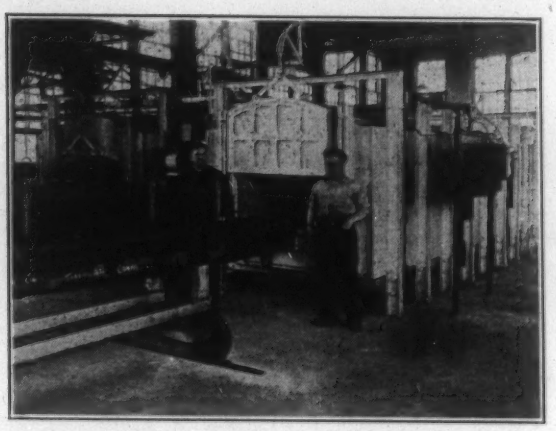
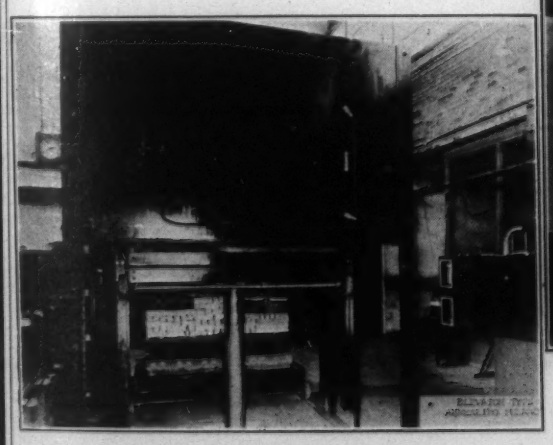
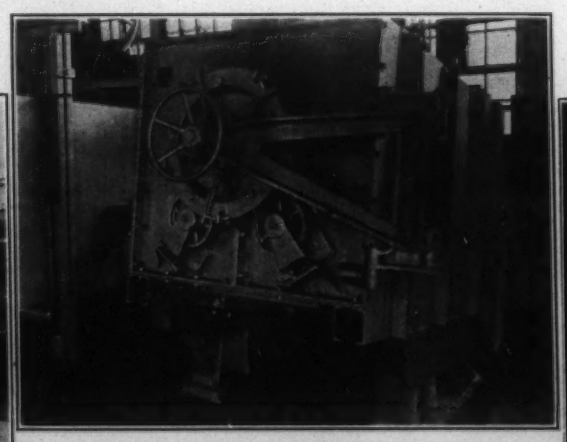


Roller Rail Tube Annealing Furnaces. 237 K.W. in three zones.



Elevator Type Annealing Furnace with Artificial Atmosphere.



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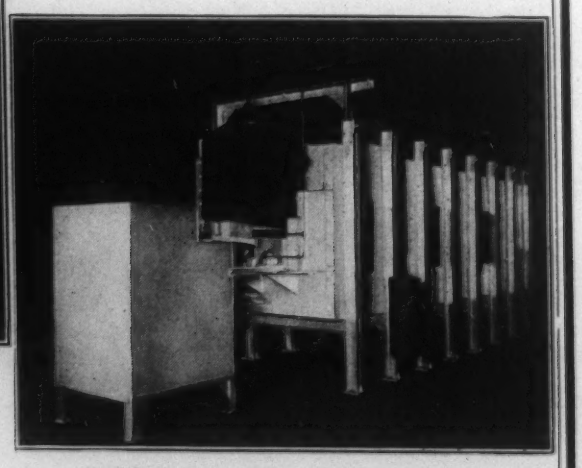

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chemical industry, according to information supplied by G. O. Hiers of the research laboratories of the National Lead Co., Brooklyn. Also, lead alloys with 1 per cent Ca or less are being used for bearing metal alloys such as "Satco" metal. The addition of lead to aluminum alloys (up to 1.5% Pb) is important in the field of free cutting or free machining metals (similar to Ledloy).

Low-Alloy, High Strength Castings

Somewhat comparable to the low-alloy, high strength structural steels is the development and production of a similar grade of steel castings—and for a similar purpose: Weight reduction with increased strength for use in bolsters, side frames, etc., in railroad equipment, and so on. Decided strides have been made with emphasis on the manganese-nickel and manganese-vanadium grades. Of late a maganese-titanium steel has appeared and reports concerning its success are reliable, with interesting possibilities.

Machine Tools

There have been striking changes in the materials incorporated in machine tools in quite recent years—greater use of alloy cast iron (Ni, Cr, V and Mo), of alloy steels and of non-ferrous alloys, substituted for the plain irons and steels. This has resulted in almost revolutionary developments in the efficiency and accuracy of these highly important machines. The scope of this development is authoritatively discussed by an article in our September and October issues.

Silver

Expanding industrial uses of silver has been a leading development in the decade. A pictorial article in this issue depicts one phase of this as carried out by a leading producer of silver alloys. Powder metallurgy has entered this field commercially. There have been experiments in the use of silver as an alloy in stainless steel and in non-ferrous alloys. The researches of Battelle Memorial Institute in the development of silver alloy bearings have produced valuable results.

Other Items

Much has been learned about precipitation hardening during the decade. This is particularly true in the non-ferrous metals. This is touched on by one or two of the reviews. In steel, both copper and some other alloys are precipitation, or age-hardening, alloys.

Continued progress has been made in centrifugal casting in both the ferrous and non-ferrous fields. Witness the use of ferrosilicon in the Delavaud process and the recently developed process of the Ford Motor Co. for producing differential and rear axle gear blanks. Another company is said to be casting unusual shapes centrifugally. The prospects in this field are encouraging.

In induction melting and heating decided advances have been made. Within the decade large Ajax high frequency furnaces up to 4-ton capacity have been installed. The use of induction heating in heat treating is an outstanding development which has reached the commercial stage not only in selective heat treating of crankshafts (Tocco process) but also of many other both cylindrical and irregular shapes. A new development is the hardening by induction of the internal surface of pipes, cylinders and the like.

In forgings, distinct progress has been made in the production of both hammer and drop forgings of alloy and stainless steels.

Some Related Articles in METALS AND ALLOYS

"Carbon Linings for Blast Furnaces," by F. Singer—Apr., 1939.
"Industrial Uses of Titanium," by G. F. Comstock—Oct., Nov., 1938.
"Phosphorus as an Alloying Element in Steel," by H. W. Gillett—Oct., Nov., 1935.
"Phosphorus as an Alloying Element in Low-carbon, Low-alloy Steels," by C. H. Lorig and D. E. Krause—Jan., Feb., Mar., 1936.
"Beryllium and Its Alloys," by J. Delmonte—July, Aug., Sept., 1936.
"Bearing Metals of Lead Hardened with Alkali and Alkaline Earth Metals," by L. E. Grant—Aug., Sept., 1934.
"Properties of Free-machining, Lead-bearing Steels," by J. H. Nead, C. E. Sims and O. E. Harder—Mar., Apr., 1939.
"Low Alloy Steel Castings," by A. Finlayson—Sept., 1937.
"Silver-rich Alloys as Bearing Materials," by R. W. Dayton—Dec., 1938.
"Ford Centrifugally Cast Steel Gears," by E. F. Cone—Oct., 1938.
"Stainless Forging Metals," by W. Naujoks—May, 1939.
"The Role of Nickel in the Machine Tool Industry," by J. W. Sands and D. A. Nemser—Sept. and Oct. 1939.

Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Precipitation Hardening

Kempf (page MA 32 R 2) gives a good introduction to the principles of precipitation hardening, addressed to foundrymen, but useful to metallurgical engineers in general.—H.W.G.

High Yield Strength Steels

Hoff (page MA 54 L 1) gives an interesting picture of the status of such steels in Germany even though the attitude toward other countries' developments is a smug one.—H.W.G.

Kick Out the Cementite

According to Naumann (page MA 58 L 7) the secret of avoiding attack by hydrogen upon steel at high temperature and pressure, is to alloy it so that Fe_3C is replaced by more stable alloy carbides.—H.W.G.

Flame-Cutting of Cast Iron

Cast iron is much more resistant to oxidation, and hence to flame-cutting, than steel. Nevertheless, flame-cutting of cast iron is accomplished quite readily by a special combination of flame adjustment and cutting technique. The preheating flames are adjusted to be carburizing; tips and oxygen pressure are the same as for cutting mild steel.

The best technique is as follows: Play the preheating flames along the line of cut, from top to bottom, until the cast iron is well heated at the place where the cut is to start. Then turn on the cutting oxygen. As soon as the cut has started, manipulate the torch to give the tip a semicircular oscillating motion extending equally each side of the kerf centerline, and advancing slowly to make the cut. Watch carefully that the advance is kept in step with the cutting action. A relatively smooth-appearing cut will result.

Flame-cutting of cast iron is limited at present to demolishing castings and to making alterations and repairs to machinery. Where heavy parts are to be removed, particularly in close quarters, the cutting torch saves time and money. Alterations to machines often require only a part of a casting to be cut away. Repairs of cracks or breaks in large cast iron members by welding require preparation of the section by veeing. Here the cutting torch is of great value. The most extensive present application of flame-cutting of cast iron is probably for this operation (page MA 34 L 9).—E.V.D.

Al Cable Sheath

Herrmann (page MA 60 R 8) reports that high purity Al is replacing Pb for cable sheath to some extent in Germany. Sufficient plasticity is claimed to be achieved by an anneal at 350 deg. C., which gives an elongation of 40-55 per cent.—H.W.G.

High Test Iron

Piwowarsky (page MA 16 L 7) questions whether going to tensile strengths above 50,000 lbs. per sq. in. by reduction in C content of cast iron does not so reduce the chances of getting good castings as to do more harm than good to the foundry industry.—H.W.G.

The Auto-squeezing Mold

Erichsen (page MA 19 L 7) describes a mold for casting billets, made of high expansion Ni steel, which, as it heats up from the molten metal poured into it, progressively decreases the volume of the mold cavity, so that feeding is claimed to be unnecessary.—H.W.G.

Ferrosilicon

In order to avoid the possibility of evolution of PH_3 during storage or shipment of ferrosilicon, the P content is held low. Liebscher (page MA 15 L 10) comments that P-free iron scrap, or wrought iron, are used as raw material to supply the Fe. It seems odd to class wrought iron, which is usually very high in P, together with P-free iron scrap, whatever that is. "Free" must be a relative term.—H.W.G.

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Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Molds for Centrifugal Castings

According to a German article (page MA 84 L 7) special bronzes high in Al have been developed as a material for centrifugal molds. They contain 3 to 11 per cent Al and 15 to 5 Ni + Fe. For iron molds additions of 1 to 10 per cent Al are suggested. Such molds, when first used, are covered with a thin skin of Al_2O_3 which retards heat transition from molten metal to mold, thus preventing excessive stresses in the mold and guaranteeing more uniform cooling conditions and increasing mold durability.—E.F.C.

Metals in Aircraft

Metallurgical engineers in the aircraft industry achieve maximum strength/weight ratio by using either high-strength metals or light-weight metals, or judicious combinations of both. An article in *Steel* (page MA 114 R 2) discusses carbon, alloy and stainless steels used in aircraft, while Le Coeuvre (page MA 116 R 1) exhaustively treats of light metals in the same field. Whether you favor stronger heavy metals or lighter weak metals, or are undecided, you'll find much of interest in both articles.—F.P.P.

Steels for Chisels

A summary of the chisel steels used in England is offered by Sanderson (page MA 94 R 1) together with the heat treatment applied. They vary all the way from plain carbon to those containing W, Cr or V, one or all of these—E.F.C.

"Were t'other dear charmer away"

Smithells (page MA 110 L 3) remarks that one doesn't have hydrogen unsoundness or oxygen unsoundness in metal frozen from a melt; unsoundness occurs only when both are present together.—H.W.G.

Grain Size Determinations

To the methods for determining austenitic grain size, Baruzdin (page MA 112 L 10) adds hydrogen etching of the grain boundaries under reduced pressure at the desired elevated temperature.—H.W.G.

Electroplating on Aluminum

Electroplating of harder or more corrosion-resistant metals on Al aids the designer in building parts that combine the light weight of Al with the often more desirable surface properties of heavy metals. Two articles this month (pages MA 104 L 6 and MA 105 L 10) are concerned with electroplates on Al, with operating details and applicability of available processes given.—F.P.P.

Physiology

Brisbois and Cartwright (page 84 L 6) mention "straight-sided, round-shouldered, short-necked heads," Herrmann (page MA 102 R 8) the "backside" and at first we thought Le Coeuvre's "chignolle" (page MA 116 L 2) had something to do with a hair-do. Exhaustive investigation in technical dictionaries reveals that a chignolle is a small bevel gear hand drill.—H.W.G.

Controlling the Open Hearth

Application of automatic control equipment to open-hearth furnaces is discussed by Bradley (page MA 86 L 1). Among the benefits cited is a better quality of steel at about half the average of 6,400,000 B.t.u.'s used to produce a ton of ingots in 1928-1929. Comparison of before-and-after costs of operation shows average savings of 9 per cent in tonnage, 12 per cent in refractories and 8 per cent in fuel.—E.F.C.

Fish Scale in Enameling

Two articles on this not entirely piscatorial problem are abstracted this month. Kerstan (page MA 106 R 1) gives a remarkably thorough, practical report on the causes of fish scale formation; and Hoff and Klärding (page MA 106 R 6) concentrate on a single factor believed to be the culprit. Paeans of praise from the abstractor emphasize the value of both contributions.—F.P.P.

Cutting the Cloth

Textiles and sewing may seem a long way from metallurgical engineering, but Kent (page MA 105 R 5) points out that proper choice of cloth, method of assembly and details of sewing make lots of difference in buffing wheels.—H.W.G.

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Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Low-Temperature Brazing Alloys

Research work in recent years has developed new brazing alloys (MA 155 L 9) with lower melting points. Some of these are silver alloys, which incorporate the brazing characteristics of silver solder in compositions containing less silver—in certain cases as little as 10%. Other new brazing alloys are composed of copper and phosphorus.

One new silver brazing alloy contains 15% silver, 80% copper and 5% phosphorus. It is widely used for joining non-ferrous metals, principally copper, brass and bronze. It has a melting point of 1185 deg. F. and is free-flowing at 1300 deg. F. Another new silver brazing alloy has a medium silver content of approximately 50%, and the balance of about equal portions of copper, zinc and cadmium; it has an extremely low melting point (1160 deg. F.) and almost universal applicability.

Low-temperature brazing fluxes, that begin to fuse at about 800 deg. F., and at 1100 deg. F. are thin, active fluids which ensure thorough wetting of joint surfaces by these brazing alloys, are used. The combined use of the low-temperature brazing fluxes and the low-temperature brazing alloys makes possible an excellent joining medium, operating at low working temperatures. These new developments have broadened the field of application, and low-temperature brazing alloys are now used extensively for a great variety of work.—E.V.D.

High-Cr, Low-W High-Speed Steels in Russia

Steels with C 1.10, Cr 9.20, W 2.38, V 0.81 and C 0.98, Cr 8.68, W 4.08, V 1.56 are reported to stand up better than W 18, Cr 4, V 1 in cutting tests in "Low-Tungsten Substitutes for High Speed Steel" (page MA 148 L 3). This abstract also reports the amount of retained austenite after quenching and after single and triple draws at different temperatures. Do our high speed steels retain 65% austenite on quenching in oil and 29% after a single draw at 550° C. (1022° F.)?—O.E.H.

Two Points of View

Den Hartog and Rodgers (page MA 155 L 8) consider that cracking of welds is due to structural modification and not avoided by a stress-relieving anneal. Weisberg (page MA 156 R 8) finds that C-Mo piping must be preheated before welding and not allowed to cool before stress-relieving, if cracks are to be avoided.—H.W.G.

Blowholes in Castings

Bollenrath and Schiedt (page MA 145 R 6) remark that even in aircraft castings of light alloys, small blowholes are admissible if they are not in locations of maximum stress concentration.—H.W.G.

Die Dunking

Brass die castings are made with smooth surfaces (page MA 145 R 8) by dunking the die in a water suspension of some coating material between casts. But won't this slow up production, besides being mighty tough on the dies?—H.W.G.

Methuselah

According to Rowe (page MA 144 R 6) natural siliceous sands are "and always will be" the most common material for molds for non-ferrous castings. No such statement can be disproved, but how can one be certain that no radical change can take place in anything relating to metallurgical engineering?—H.W.G.

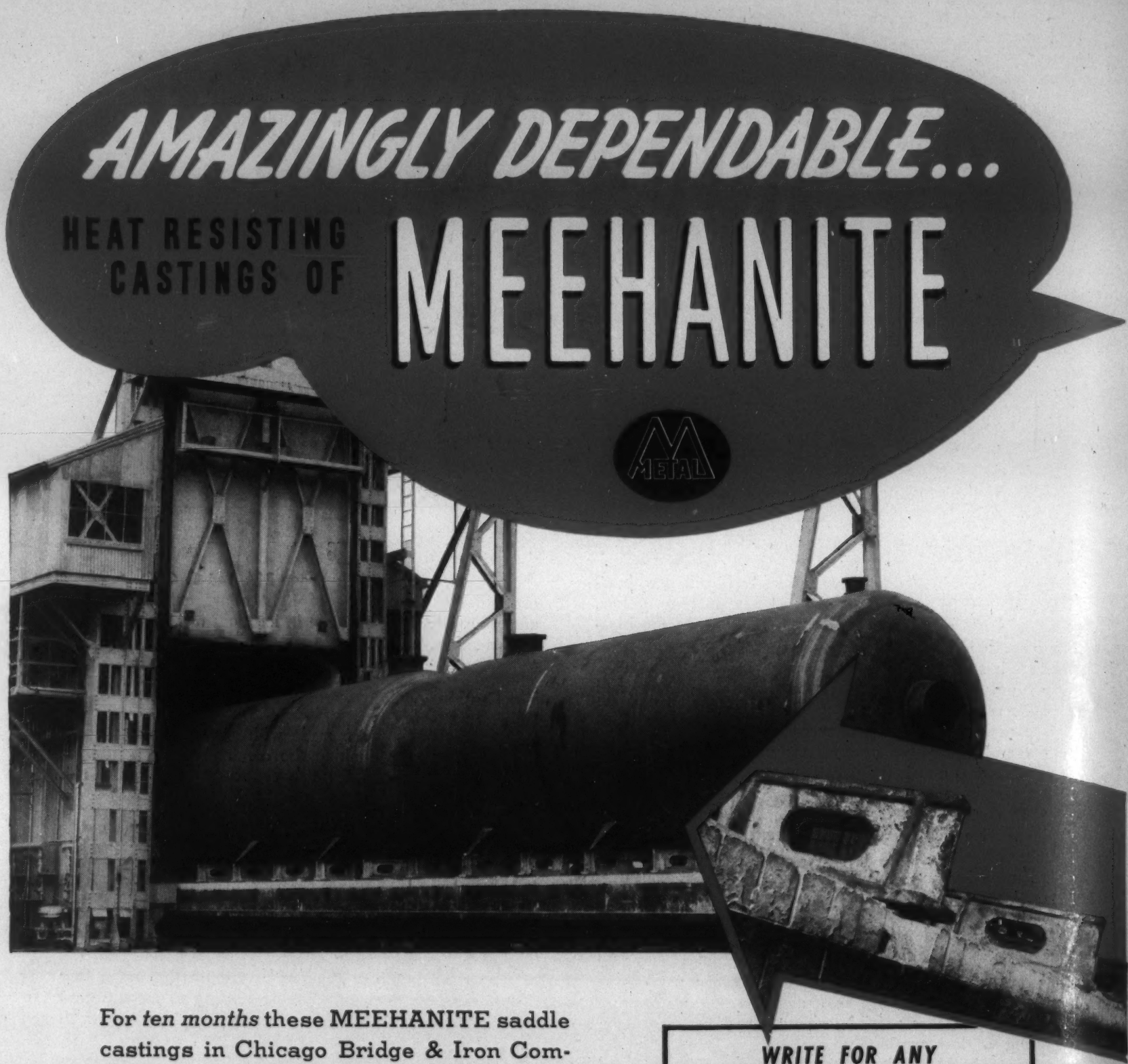
Powder Metallurgy

Honisch (page MA 183 L 2) cites several ways of making metal powder for pressing and sintering, but omits electrodeposition at a current density selected to produce a non-adherent deposit.—H.W.G.

Welding Molybdenum Steels

C-Mo steels are commonly preheated before welding and stress relieved afterwards. Welds made in this manner have practically the same tensile strength, elongation and impact value as the parent metal. Existing data, while incomplete, indicate good creep resistance of such welds also. Properly made welds in Mn-Mo, Ni-Mo and Ni-Cr-Mo steels also possess good physical properties.

From the standpoint of recovery in welding, Mo is one of the easiest elements to control. In the case of covered electrodes, up to 1% Mo has been introduced into the weld-metal from the coating. The percentage recovered decreases as the Mo content of the coating increases. Mo slightly increases the recovery of C in the weld-steel also (MA 160 R 9).—E.V.D.



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Foreword

by L. F. REINARTZ

L. F. Reinartz
Chairman, Open-Hearth Committee

THE National Open-Hearth Committee of the American Institute of Mining and Metallurgical Engineers will hold its annual conference in the Cleveland Hotel, Cleveland, on April 26, 27 and 28. At the same time and place the Blast Furnace and Raw Materials Committee of the Institute will hold a meeting. From all indications, a record number of managers, open-hearth superintendents, metallurgists, chemists, and other operating men will be present at this conference to help discuss many problems of practical interest to steel men.

Five technical sessions will be held during the open-hearth conference, and three sessions will be held by the blast furnace and raw materials group.

During the first open-hearth session on the morning of April 26, a question, which is of vital interest to all operators at this time, will be discussed: "Employer-Employee Relations in the Steel Plant." Subjects such as safety, foremen training, metallurgical observers, checking open-hearth practice, and handling of grievances will be discussed. R. K. Clifford, general superintendent, Kokomo Works of the Continental Steel Corp., will preside. C. R. FonDersmith, open-hearth superintendent of Middletown Works, American Rolling Mill Co., will be vice-chairman.

At their first session during the morning of April 26, the blast furnace group will discuss the effect of solution loss reactions on blast furnace economy, and effects of low slag volume on cost and quality. H. A. Strain, assistant general superintendent of Carnegie-Illinois Steel Corp., Chicago, will be chairman and W. E. Brewster, blast furnace superintendent, Wisconsin Steel Works, will be vice-chairman.

At noon both committees will attend a welcoming luncheon. Harold Burton, mayor of Cleveland, and D. B. Gillies, president of the A.I.M.E. will address the group.

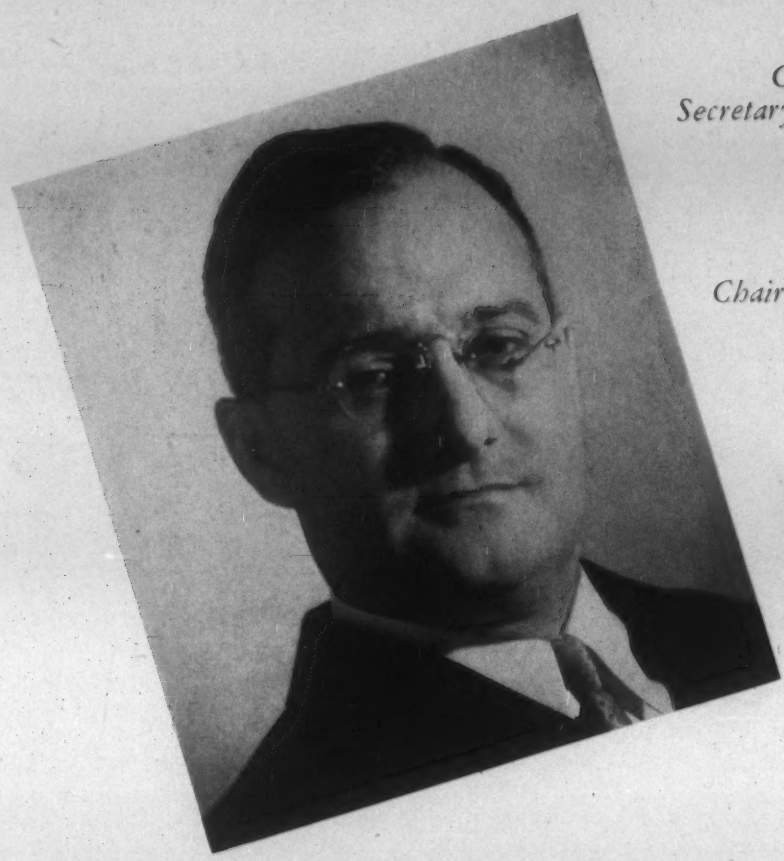
E. C. Smith, chief metallurgist, Republic Steel Corp., Cleveland, is chairman of the Cleveland local reception committee. Other members of this committee are: Walter M. Charman, W. F. Conlin, Huntington Downer, Howard P. Eells, Jr., Carl P. Guthrie, J. D. Knox, Paul J. McKimm, and C. A. Thayer.

The open-hearth committee will discuss the use of refractories during the afternoon session on Wednesday, April 26. Invitations have been sent to members of the refractory division of the American Ceramic Society to take part in these discussions. Gilbert Soler, research manager, Timken Roller Bearing Co., will act as chairman, and Harley C. Lee, Columbus, Ohio, will assist him as vice-chairman. Some of the subjects for discussion are: (a) New ideas for the installation of furnace bottoms with particular reference to plastic chrome bottoms. (b) Improvements in checker construction. (c) Refractories for tap holes, runners, ladle accessories and hot tops. (d) How can the open-hearth operator be assured of uniform and satisfactory refractory material?

At the afternoon session the blast furnace committee will hear about blast furnace practice in South Africa, and will discuss freight cost of iron ore, and a low temperature, vacuum process for iron ore reduction. Horace Allen, Evergreen Mines Co., Cleveland, will act as chairman, and J. H. Slater as vice-chairman.

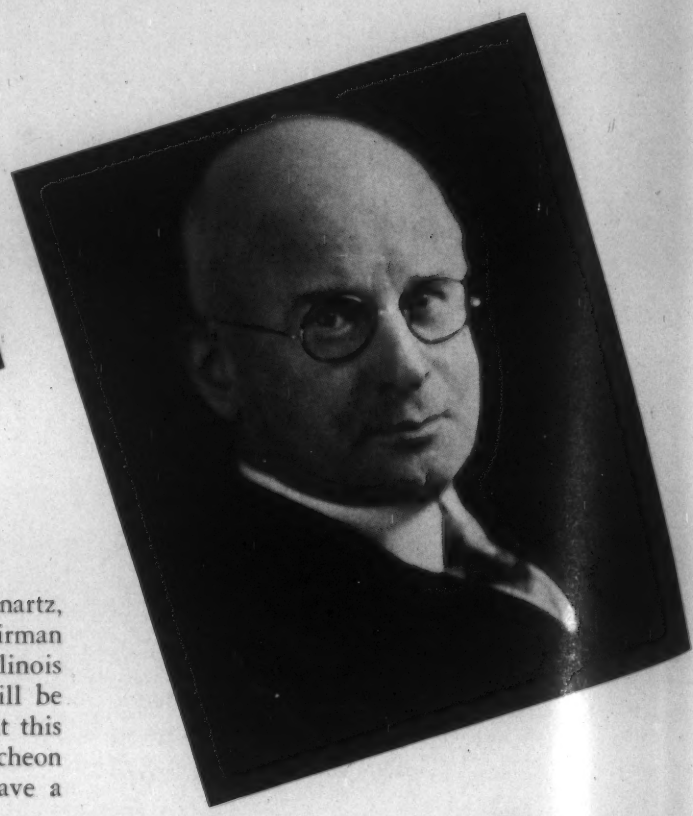
The Thursday morning conference will be devoted to a joint discussion by both committees of problems which are of vital interest and importance to both groups. Such subjects as:

What the open-hearth requires from a blast furnace.
How open-hearth requirements can be met.
Economical amount of open-hearth slag used in a blast furnace.
Use of mixer type ladles.
Substitution of blown metal.
Effect of hot metal analysis and casting temperature on the quality of open-hearth steel.



Clyde E. Williams
Secretary, Open-Hearth Committee

R. H. Sweetser
Chairman, Blast Furnace Committee



are some of the interesting topics that have been provided for discussion. L. F. Reinartz, manager, Middletown Works of the American Rolling Mill Co., will be general chairman of this session. J. W. Kinnear, chief metallurgist, Homestead Works of Carnegie-Illinois Steel Corp., and A. J. Boynton, vice president, H. A. Brassert & Co., Chicago, will be co-chairman. A lot of valuable and enlightening information should be developed at this session. At noon the executive committee of the open-hearth will hold a luncheon meeting. The members of the blast furnace and raw materials group will also have a luncheon meeting.

During the afternoon of April 27 the members and guests of the joint committees will visit the large modern plant of the Republic Steel Corp. in Cleveland.

At 6:30 p.m. there will be a cocktail party in the Cleveland Hotel followed by the annual good fellowship dinner at 7:30 p.m. Harry Sain, special representative of the Industrial Commission of the State of Ohio, will deliver a short, inspirational and humorous talk on the subject: "Safety in the Steel Plant."

Friday morning the open-hearth group will discuss operations in the open-hearth department. At this session the following subjects will be discussed: (1) Description of a pilot open-hearth furnace. (2) Construction and operation of a new furnace at the Pittsburgh Steel Co. (3) Instrumentation on a modern open-hearth furnace. (4) Pyrometers for metal bath temperatures. (5) Bottom pouring practice. (6) Crowe slag pockets. (7) Description of a novel design for an open-hearth furnace without a front wall. (8) Use of light weight scrap. A. P. Miller, assistant general superintendent of Inland Steel Co., will be chairman of this session, with W. C. Kitto, open-hearth superintendent, Pittsburgh Steel Co., vice-chairman.

During the afternoon of April 28, the open-hearth group will discuss quality problems connected with the manufacture of open-hearth steel. As usual, this conference should create a great amount of interest. Questions relating to effect of aluminum on grain size in killed steels, use of other deoxidizers on grain size, effect of patching furnace bottoms on grain size control, use of silico-manganese in forging and other steels, as well as the effect of mold design on the quality of killed steels will be discussed.

A great many subjects coming under the classification of rimming steel will be discussed. Some of these are:

(a) Best FeO content of slag for rimming 0.20 per cent carbon steels.
(b) Percentage of automobile scrap used in making extra deep drawing steels.
(c) Effect of high and low residual manganese on rimming steels.
(d) Best place for aluminum additions—in ladle or in molds.
(e) What defects in finished steel can be traced back to open-hearth practice.

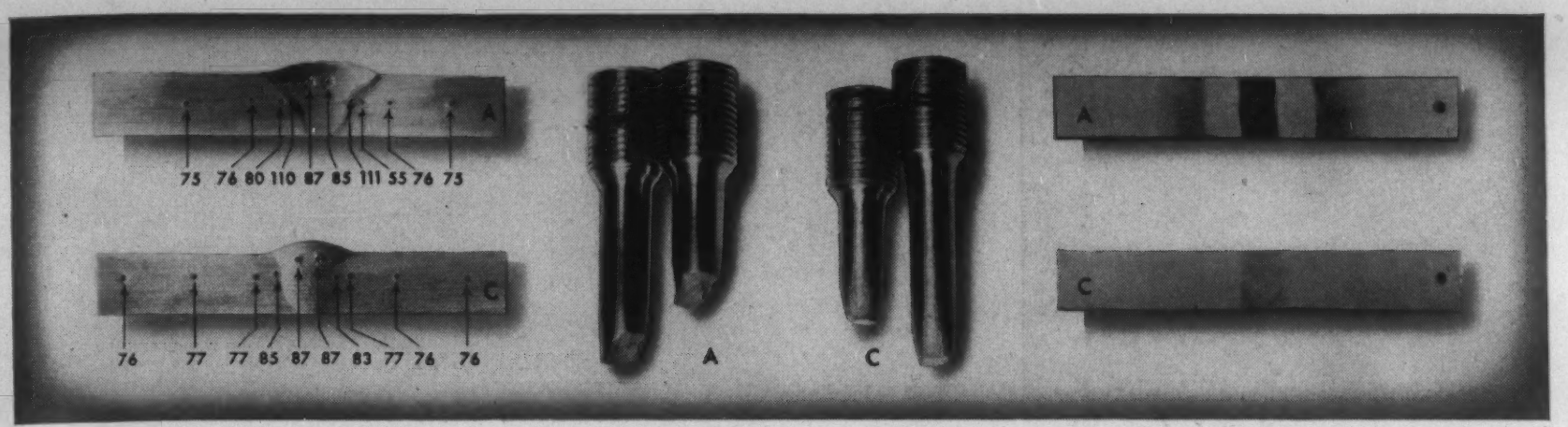
Slag control will come in for its share of discussion. Many of the methods now in current use will be discussed.

At this conference a synopsis of a paper read at the St. Louis Iron & Steel Scrap convention showing types of scrap available for open-hearth use will be read.

All open-hearth operators will receive a copy of the complete program early in April, and each individual is asked to familiarize himself with the questions, and be prepared to enter the discussion. The experience of those who have attended these meetings the longest, and secured the most benefit, is that only if each member or guest gives the group the benefit of his personal experience can there be a frank exchange of ideas for the benefit of all those attending the conference.

F. H. Crockard
Secretary, Blast Furnace Committee

How COLUMBIUM Simplifies Welded Fabrication of High-Chromium Steels



Rockwell B hardness is indicated on these 4 to 6 per cent chromium steels welded with 24 per cent chromium-12 per cent nickel rod, tested as welded. Steel A contains no columbium; steel C contains 0.51 per cent columbium. Note that the columbium-bearing steel is practically free from air-hardening in the zone adjacent to the weld.

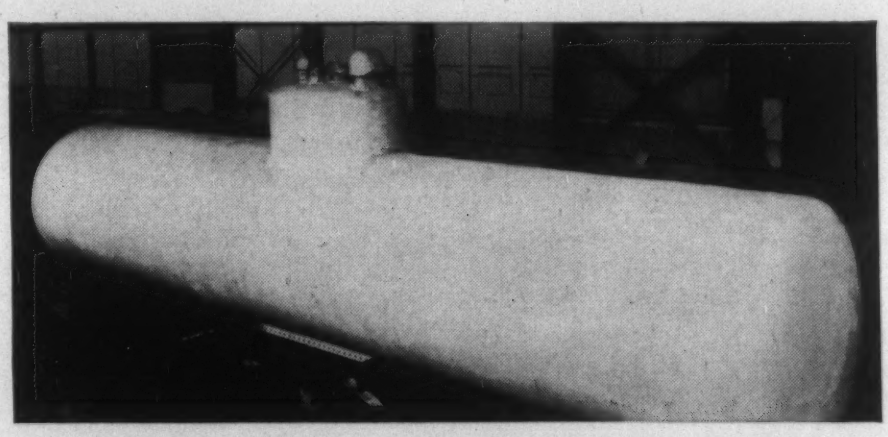
These tensile specimens are 12 to 14 per cent chromium steels air-cooled from 1650 deg. F. Steel A contains no columbium; steel C contains 0.80 per cent columbium. Notice how soft and ductile the columbium-bearing steel appears. The test results indicate that steel C actually is about twice as ductile and less than one-third as hard as steel A.

These 18 per cent chromium-8 per cent nickel steel specimens were oxy-acetylene welded and then exposed to hot nitric-hydrofluoric acid. Steel A, without columbium, shows severe corrosion in the zones adjacent to the weld. Steel C, with 0.44 per cent columbium in the plate and 0.99 per cent columbium in the welding rod, shows no corrosion.

IN steels containing from 3 to 16 per cent chromium, columbium minimizes air-hardening. In stainless steels of the 18 per cent chromium—8 per cent nickel type, columbium prevents intergranular corrosion even after long exposure to temperatures ranging from 750 to 1650 deg. F. Hence, when all these chromium steels contain a small amount of columbium and are welded with columbium-bearing welding rod, subsequent annealing is unnecessary. This eliminates a costly and time-consuming fabricating step . . . You should specify columbium in your high-chromium steels to lower fabricating costs.

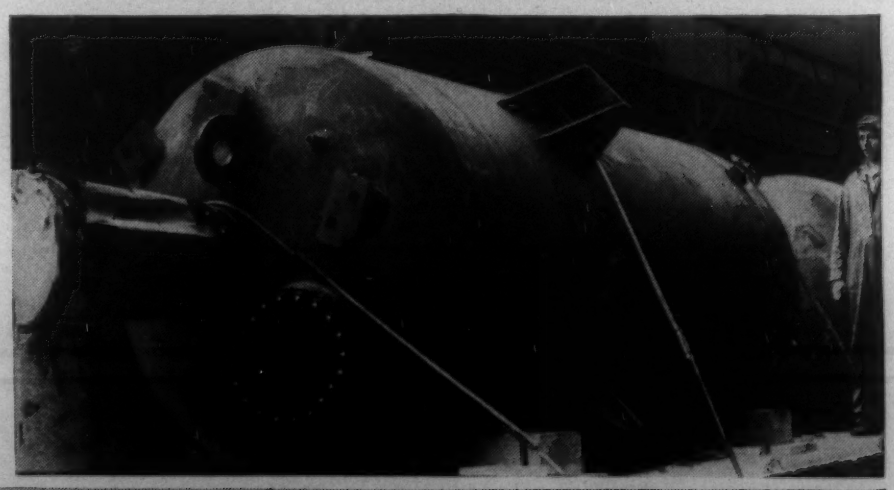
For over thirty years, we have produced "Electromet" ferro-alloys and metals for use in making steel. Ferrochromium for adding chromium to steel and ferrocolumbium for adding columbium to steel are two of these ferro-alloys. If you make steel, our metallurgists will gladly help you use "Electromet" ferro-alloys to meet the analysis your specifications call for. If you use steel, information and metallurgical assistance are available to make your use of alloy steels more profitable.

The word "Electromet" is a registered trade-mark of Electro Metallurgical Company.



Because this 8000-gallon chemical tank was made of columbium-bearing stainless steel welded with columbium-bearing welding rod, it did not have to be annealed after welding to assure full corrosion resistance.

Quenching of this 16-foot-long autoclave from a resolution temperature of 2000 deg. F. was eliminated by constructing it of columbium-bearing stainless steel welded with columbium-bearing welding rod.



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Tentative Technical Program

Wednesday, April 26

9:00 A.M.—Registration—Open-Hearth and Blast Furnace and Raw Materials Committee—Mezzanine Floor

Open-Hearth Committee

10:00 A.M.—Opening Address—L. F. Reinartz, general chairman, National Open-Hearth Committee, A.I.M.E., Ball Room (Mezzanine Floor)

Session on Industrial Relations

R. K. Clifford, Chairman; C. R. FonDersmith, Vice Chairman

"The Settling of Grievances" by Russell Chaffin, director of industrial relations, Continental Steel Corp., Kokomo

"Safety in the Open-Hearth" by C. R. FonDersmith, superintendent open-hearth, The American Rolling Mill Co., Middletown

Subjects for Discussion

(a) Training and practical use of metallurgical observers in the open-hearth
(b) Training foremen and men in the open-hearth department to follow cost, quality, fuel and repairs
(c) What is done to improve working conditions in the open-hearth department
(d) Checking open-hearth practice for quality

Blast Furnace and Raw Materials Committee

10:00 A.M.—Opening Address—Ralph H. Sweetser, chairman, Blast Furnace and Raw Materials Committee, A.I.M.E.—Empire Room (Parlor Floor)

Session on Solution Loss and Slag Volumes

H. A. Strain, Chairman; W. E. Brewster, Vice Chairman

"Effects of Solution Loss Reactions upon Blast Furnace Economy" by P. V. Martin, asst. supt. blast furnaces, South Works, Carnegie-Illinois Steel Corp., Chicago.

"Low Slag Volumes and Resulting Effects on Cost and Quality" by G. E. Steudel, division supt. of blast furnaces, South Works, Carnegie-Illinois Steel Corp., Chicago

12:15 P.M.—Welcoming Luncheon—Open-Hearth and Blast Furnace and Raw Materials Committee—Red Room (Mezzanine Floor)

Addresses of Welcome

Harold Burton, mayor of Cleveland;
D. B. Gillies, president, A.I.M.E.

Open Hearth Committee

2:00 P.M.—Session on Open Hearth Refractories

Gilbert Soler, Chairman; Harley C. Lee, Vice Chairman

1. Discussion of Furnace Bottoms:
   a) Plastic chrome bottoms
   b) Use of various types of magnesite, such as Seawater, Thomasite, Austrian, Canadian, Washington, etc.
   c) How to keep bottoms clean. How are old bottoms resurfaced? What materials are used?
2. Use of Basic Brick and Other Special Materials in Open-Hearth Furnaces other than Bottoms:
   a) Bulkheads
   b) Back walls
   c) Roof
3. Improvements in Checker Construction:
   a) Special brick and special settings
   b) Multiple checkers
   c) Other designs
   d) Do checkers run hotter in insulated furnaces?
4. Refractories and Tapholes:
   a) Materials used
   b) Control practice
5. Runners and Ladles:
   a) What progress is being made with basic materials?
   b) Other materials and designs
   c) Methods used for lining ladles; composite ladle lining (2 different types of brick—same ladle)
6. Ladle Accessories: Sleeves, Stopper Heads and Nozzles:
   a) Materials and designs in use for sleeve brick
   b) Materials and designs in use for stopper heads
   c) Materials and designs in use for nozzles
   d) Type of bond between the sleeve brick and mixtures used for nozzle well.
   e) What special qualities are desired for a nozzle?
7. Hot Tops and Mold Plugs:
   a) Various types of hot tops in use
   b) Relative advantages of permanent hot tops vs clay hot tops, in different types of steel in regard to cost and quality
   c) Mold plugs
8. What Refractory Specifications Are Necessary for the Open-Hearth Operator in Order to Obtain Uniform and Satisfactory Refractory Materials?
   a) Bottom materials
   b) Basic and chrome brick, etc.
   c) Ladle brick and fire brick
   d) Silica brick
   e) Pit refractories: Sleeve brick, stoppers, nozzles, hot tops, mold plugs
   f) Other refractory materials

(Continued on Page A11)

(Continued from Page A10)

9. Needs for Future Development by the Refractories Industry in Order to Increase the Operative Efficiency, Improve Quality and Lower Overall Cost in the Open-Hearth.

Blast Furnace and Raw Materials Committee

2:00 P.M.—Session on Operating Practice; Raw Materials
Horace Allen, Chairman; J. H. Slater, Vice Chairman

"Blast Furnace Practice in South Africa" by J. A. L. Ortlepp, African Metals Corp., Johannesburg
"Low Temperature—Vacuum Metallurgical Process" by Alfred Musso, Cons. Engr., New York City
"Freight Costs of Iron Ore" by H. M. Roche, Cons. Engr., Dover, N. J.

Thursday, April 27

9:30 A.M.—Joint Session—Open-Hearth and Blast Furnace and Raw Materials Committees

L. F. Reinartz, General Chairman
J. W. Kinnear, Jr., Co-Chairman for Open-Hearth
A. J. Boynton, Co-Chairman for Blast Furnace

Subjects for Discussion

What the open-hearth requires from the blast furnaces Meeting the open-hearth requirements.
What is the economical amount of open-hearth slag that can be used in the blast furnace with respect to final ingot costs?
Have mixer type ladles justified their adoption—(1) where they have replaced small ladles; (2) for new installations?
To what extent may blown metal be substituted for steel scrap. What grade of iron is most economical for the production of blown metal?
Can the use of high silicon iron in the open-hearth be justified by the extra amount of iron ore it will reduce?
"Effect of Hot Metal Analysis and Casting Temperature on Open-Hearth Quality" by L. H. Nelson, asst. open-hearth supt., Republic Steel Corp., Buffalo, N. Y.

12:15 P.M.—Executive Committee, Open-Hearth Committee—Luncheon Meeting

12:15 P.M.—Blast Furnace and Raw Materials Committee—Luncheon Meeting

Inspection Trip

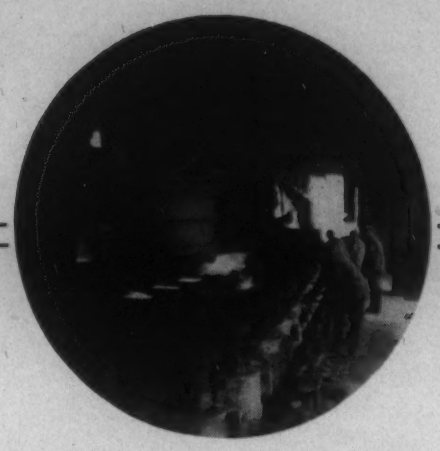
2:15 P.M.—Plant Visit—Open-Hearth and Blast Furnace and Raw Materials Committees—Republic Steel Corp., Cleveland Plant. Chartered buses will leave the Hotel Cleveland at 2:15 p.m. for the plant. Members and delegates will be guided through the 98-in. continuous strip mill, the largest continuous mill in the world. Buses will leave the plant at 5:00 p.m. for the return trip to the hotel.

6:30 P.M.—Cocktail Party—Red Room

7:00 P.M.—Fellowship Dinner-Smoker—Ball Room. Tickets $2.50 including Cocktail Party

Speaker: Harry Sain, special representative, Industrial Commission of Ohio—"Safety in the Steel Plant"

(Continued on Page A12)



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LAPIX definitely reduces porosity and secondary pipe. Introduced a year ago and widely discussed at last year's Open Hearth Meeting, this insulating material substantially reduces top discards. Smokeless, odorless, finely powdered, LAPIX has a positive record of increasing ingot yield as much as 3%. Only 1½ lbs. are needed per ton of ingot, therefore adequate protection is afforded at an average cost of 6 cents per ton. For further information call the Houghton Man.

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Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects or the smallest streams; no correction charts to consult, no accessories, no upkeep. New concentrated test mark and ease of operation permit unusually close and rapid temperature determinations. PYRO is standard equipment with the leading plants in your industry.
Stock Ranges 1400° to 5500° F.

Pyro Radiation Pyrometer

The ideal instrument for Furnace or Kiln use. Gives actual heat of material aside from

furnace or kiln temperature. Does not require a skilled operator—strictly automatic. Eliminates personal errors. Always ready to tell within three seconds any shortcomings in your equipment.

Write for special bulletins.

The Pyrometer Instrument Co.
107-9 Lafayette St. New York City

(Continued from Page A11)

Friday, April 28

Open Hearth Committee

9:30 A.M.—Session on Open-Hearth Operations—Ball Room
A. P. Miller, Chairman; W. C. Kitto, Vice Chairman

"Construction and Operation of an Experimental Open-Hearth Furnace" by Harold K. Work, manager of research and development, Jones and Laughlin Steel Corp.

Subjects for Discussion

Discussion of the construction and operation of the new furnace at the Pittsburgh Steel Co.

Instrumentation of the modern open-hearth furnace:
- a) Draft control
- b) Automatic fuel air ratio control
- c) Automatic reversal
- d) Roof temperature control

Special pyrometers for bath temperature recordings

Bottom pouring practice:
- a) Improvement of the ingot surface compared to top pouring and is it justified
- b) Tundish or basket pouring practice
  - 1. Improvements in surface and interior quality of ingots

Crowe slag pockets:
- a) Application
- b) Advantages

Use of Light Scrap

Open-Hearth Committee

2:00 P.M.—Session on Open Hearth Metallurgy
C. H. Herty, Jr., Chairman; E. G. Hill, Vice Chairman

I. *KILLED STEEL*

Does aluminum act on grain size as effectively when in a combined state, such as ferro-aluminum, as in regular stick or shot aluminum?

What other final deoxidizers other than aluminum are in use and what effect have they on grain size?

Does bottom patching material have any effect on grain size control?

On forging quality steels of large grain size, is it better to over-deoxidize in the furnace or be on the lean side in furnace deoxidation and finish deoxidation in the ladle?

The use of silico-manganese in forging and other steels

How does mold design affect the quality of the ingot?

II. *RIMMED STEEL*

In making 0.07 to 0.09% C rimming steel, will the reduction in carbon from the range 0.15 0.20% be best accomplished by oreing down the heat or bringing down the carbon with rods? Which method is preferable in regard to the oxidizing action in the steel itself?

What is the best FeO content of slag for rimming 0.20% carbon steel?

What percentage of automobile scrap can be used in making extra deep drawing steel sheets?

Do copper additions or residual copper make rimming low carbon steel sluggish?

What effect does high or low residual manganese have on rimming steel?

In making low carbon rimming steel, where is the best place for aluminum additions—ladle—molds?

Does a 2 to 3-in. rise in a rimming ingot, due to the addition of aluminum in the mold, have the same effect on skin thickness as a rising heat from furnace conditions?

How does mold design affect the quality of the ingot?

What defects in finished sheets can be traced back to open-hearth practice?

III. *SLAG CONTROL*

To what extent has FeO control in slags been applied to everyday production of steel?

Method of slag control:
- a) Run to a predetermined iron oxide.
- b) Slag cakes as guide
- c) MnO determination
- d) Method of raising or lowering FeO
- e) Control of viscosity
- f) Lime—SiO_2 ratio

Does the use of FeO control result in being able to hold to close analysis limits. How close?

How much iron oxide can be removed from the steel through the decrease in the FeO content of the slag?

Cause and cure of foamy slags?

IV. *EFFECT OF CHARGE*

Analysis of scrap available for open-hearth use. Synopsis of paper read at St. Louis Iron and Steel Scrap Convention

Metallurgical advantages of deep vs. shallow baths. Ideal bath depth for forging steels. Why? Is more or less limestone used in a shallow hearth?

It is frequently said: "Low limestone charge is the cause for poor quality steel." Has anyone any positive evidence of this?

Which is more oxidizing—a cold pig metal or hot metal charge? Why?

Does cast iron in the charge affect the quality of steel? If limited, what per cent of total charge is permissible?

Relative advantage and disadvantages of high ore, low silicon iron in the basic open-hearth furnace

How can you be sure of a good run-off slag?

V. *GENERAL QUESTIONS*

What advantages are attributed to holding heats at the pouring platform?
- a) Length of time
- b) Kind of heat
- c) Live or killed
- d) If live steel, does a slag "boil" if a heat is held?

Working heats:
- a) Maximum ore and pig iron additions, and time of additions
- b) Effect of spar
- c) Use of sta-flux or burnt lime
- d) Use of mill cinder or roll scale
- e) Carbon at melt

In acid practice, what are the advantages in using lime in the slag and what is the best percentage?

Influence of the following factor on the speed of carbon reaction in the open-hearth furnace:
- a) Fuel
- b) Slag volume
- c) Atmosphere
- d) Temperature
- e) Influence of bath agitation
- f) Viscosity of slag

Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Supersonics

Krainer (page MA 202 R 5) gives an interesting account of the use of high frequency sound waves to "grind" ore particles. What is needed now is a means of generating the waves on a scale sufficient to handle more than a thimbleful at a time.—H.W.G.

Laps

Preparers of metallographic specimens are pretty definite these days about wanting a minimum of flowed metal and a maximum of retained inclusions. Several ways of meeting these demands are described on page MA 110. Ellinger and Acken (R 3) use 50-50 Pb-Sn disks, whereas Jarrett (L 8) prefers laps of cast iron and of lead. Modern apparatus and technique makes all the more amazing the results obtained by the early microscopists.—J.S.M.

Ersatz

Claus tells us (page MA 230 L 3) that German red brass will be standardized as 85-5-7-3 and alleges that Pb-base bearing metals have totally replaced those of Sn-base.—H.W.G.

Another Tool Alloy

Haensel (page MA 232 R 2) claims that an annealed cast iron containing 3.9 per cent C and 5 per cent Mn is suitable for a cutting tool.—H.W.G.

Cephalodic Quadrupeds

We've heard of "fish scale" but "octopus-like graphite" is a new one. "Pigs containing octopi" would make an excellent thesis (page MA 204 R 7).—C.H.H.

Flakes in Steel

Japanese investigators (page MA 208 L 4) find that H_2 is not the only cause of flakes. They are developed by thermal and transformation stresses as well as by the chemical composition.—E.F.C.

Low Alloy Steels

The forming operations of the low-alloy high strength steels are not materially affected and are practically as good as those of ordinary mild steel, says Howard Stark (page MA 218 R 3). As to welding, electrodes of comparable analyses can be secured and many of these materials have better welding qualities than either flange or fire box steel. Stark makes the prophecy that it can only be a matter of time until industry will use these low alloy steels to a very great extent.—E.F.C.

Heat Treating Light Metals

Reports are frequently published regarding Germany's expanding use of Al and Mg and their alloys. A description (page MA 216 L 6) of electric furnaces developed in Germany for the heat treatment of these products is valuable and interesting. The furnaces are large so as to accommodate the increasing size and use of the light metal structures. An interesting point is that the warping of light metal sheets by water quenching is overcome by using a spray or cold air blast.—E.F.C.

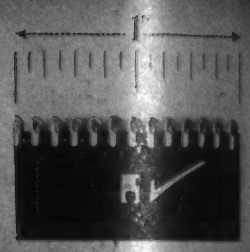
Steel from Oriental Sponge Iron

Kusaka (page MA 236 L 2), reporting on the properties of mild steel made from Chinese and Manchukuoan sponge iron, finds impact strength from 1.7 to 7 times better than that of "ordinary mild steel," depending on the heat treatment. This is the best rationalization we've had yet of Japan's course in China.—F.P.P.

Tellurium

The effects of tellurium additions are discussed in two articles this month. Hanson and Pell-Walpole (page MA 237 L 6) report improvement in work-hardenability and creep strength of tin by the addition of 0.1 per cent tellurium, while Hiers and Steers (page MA 237 L 9) ascribe improved fatigue and corrosion resistance, and useful work-hardenability to tellurium-containing lead.—F.P.P.

ZINC ALLOY DIE CASTINGS



11½ POUNDS

—or .022 gram

ZINC Alloy Die Castings are not restricted by size (within reason, of course). If a maximum or minimum were set it would probably be exceeded tomorrow.

1. SIZE—The large casting is a washing machine wringer frame—the small one (indicated with a check) is a slide fastener element. One weighs 11½ pounds and measures 18½″ x 13″ x 6⅝″. The other weighs .022 gram and measures 7/64″ x 1/16″ x 3/64″. Both are pressure die cast of ZINC Alloy.

2. INTRICACY—Whether a part be large or small, intricacy may be an important requirement. Note the *completeness* of the wringer frame casting—all of the necessary elements are embodied *in one part*. For example, provisions have been made in the end sections for fastening the wringer gearing. This means machining and assembling economies. A magnifying glass reveals the comparative intricacy of the slide fastener element, too.

3. ACCURACY—The die casting process makes it possible to secure extreme accuracy of shape and dimensions—of prime importance in the performance of the parts shown here. The ZINC Die Casting Alloys not only insure the retention of these dimensions, but they are responsible for the many other excellent physical characteristics as well.

If you would like to have more information on die castings we suggest that you consult a commercial die caster. We will be glad to answer your questions on the ZINC Die Casting Alloys.

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Annual Convention of the American Foundrymen's Association

HOTEL GIBSON, CINCINNATI, OHIO • MAY 15 TO 18

Introduction

The American Foundrymen's Association will hold its forty-third annual convention at the Hotel Gibson, Cincinnati, Ohio, May 15 to 18. There will be no exposition. The president, Marshall Post, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., will preside at the opening session, Monday morning, May 15. The Cincinnati District Chapter will act as host and has organized local committees for various activities.

Plant Visitation

In addition to the many industrial plants which will be open for inspection by small parties during the week, two special general group works visits will be organized. On Monday afternoon, May 15, the foundry and manufacturing departments of the Cincinnati Milling Machine Co. will be visited, while on Thursday afternoon, May 18, the convention will close with a visit to the Hamilton Coke and Iron Division of the American Rolling Mill Co. which will be followed by a buffet supper at the Hamilton Country Club.

Awards at Annual Dinner

The annual dinner of the Association is to be held the evening of May 17. A feature will be the presentation of three major awards of the Association. To Harold S. Falk, vice president, Falk Corp., Milwaukee, the John A. Penton Gold Medal is to be presented in recognition of his leadership in promoting foundry apprentice training. Donald J. Campbell is to be presented with the W. H. McFadden Gold Medal as president of the Campbell Wyant & Cannon Foundry Co., Muskegon, Mich., in recognition of the achievements of this company in developing casting manufacturing processes. James R. Allan, assistant manager of the industrial engineering and construction department, International Harvester Co., Chicago, is to receive the J. H. Whiting Gold Medal in recognition of his engineering contributions to the Association and the foundry industry.

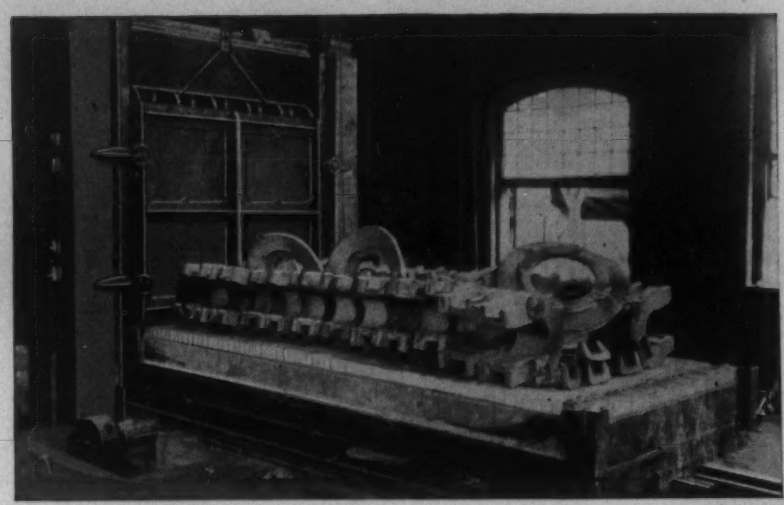
Non-Ferrous Division Dinner

The Non-Ferrous Division under the chairmanship of Harold J. Roast, Canadian Bronze Co., Montreal, has organized a social get-together dinner for Tuesday evening, May 16. As a special attraction for the members and their ladies at this dinner an address on "The Romance of Aviation" is to be given by William B. Stout, president, Stout Engineering Laboratories, Dearborn, Mich.

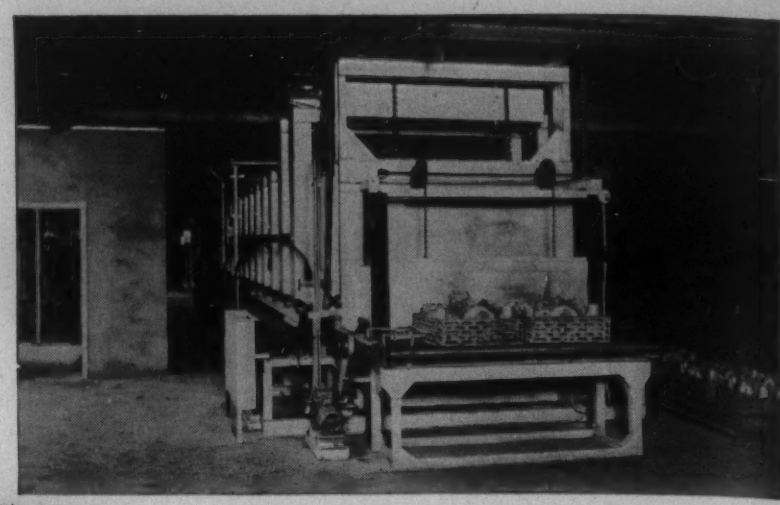
Lecture Course

An innovation this year is a three-session instructional lecture course on "The Microscope in Elementary Cast Iron Metallurgy." This course is to be given

(Continued on Page A7)



Large Steel Castings Large Steel Railroad Castings of various shapes and sizes are uniformly annealed in this single chamber car bottom type furnace.



Short Cycle Malleable Short cycle malleable castings are scale-free annealed—continuously—in this special atmosphere roller hearth type furnace.

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Electric and Fuel Fired

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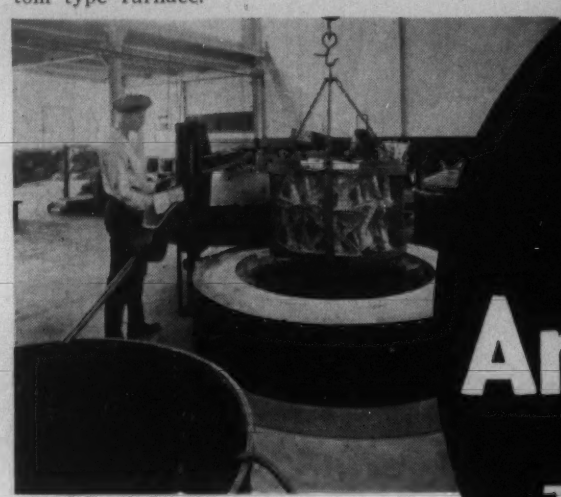
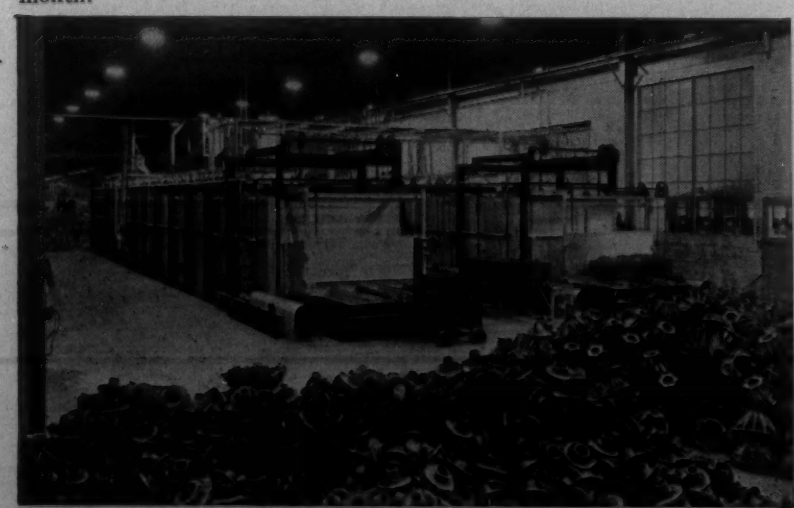


Aluminum Castings— The accurate temperature control and uniform heat distribution necessary for aluminum is proved by these circular pits.

Cast Brake Drums— Discharge end of a continuous oil fired roller hearth type furnace annealing automobile brake drums—continuously.

Steel Castings A car type installation consisting of two heating chambers, a cooling chamber, car puller and cross transfer car, for annealing 750 tons castings per month.

Annealing Valve Bodies Large valve bodies, pipe fittings and miscellaneous other castings are uniformly annealed in these two fuel fired car type furnaces.



Scale Free Annealing 40,000 lbs. of malleable castings per day are annealed absolutely scale free in these special atmosphere furnaces—The annealing time was reduced from 165 to 35 hours.

Recuperative Type Furnace Return recuperative type furnace annealing miscellaneous gray iron castings—continuously—the heat from the outgoing castings preheats the incoming material—saves fuel.

(Continued from Page A5)

by Roy M. Allen, noted metallurgical consultant, Bloomfield, N. J. Mr. Allen has revised and amplified into book form material which he presented before the 1931 A.F.A. convention. Mr. Allen's original material proved of such outstanding value that he was sought as the author of the first lecture course of the Association.

Steel Melting Symposium

For the first time in many years the Steel Division is giving special attention to a comparison of melting practices in different types of furnaces—acid and basic open-hearth, acid and basic electric, converter and induction. Each process is treated by an authority in his field and the whole will be given at the Symposium on the last day of the convention.

Technical Program

The technical program covers a wide range of papers and committee reports which will be presented in some 30 sessions. A detailed schedule of the program is given on other pages:

TENTATIVE TECHNICAL PROGRAM

Monday, May 15

MORNING

Opening Session

Address of welcome.

President's address, by Marshall Post, vice president and works manager, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

Malleable Cast Iron

"Atmospheres for Malleable Iron Annealing—Their Properties and Applications," by John Dow, Holcraft & Co., Detroit.

"White Iron for Malleableizing," by J. O. Klein, Texas Foundries, Inc., Lufkin, Tex.

"Shearing of Malleable Iron Gates," by S. D. Martin, Saginaw Malleable Iron division, General Motors Corp., Saginaw, Mich.

Nonferrous

"Production of Bronze Pressure Castings," by D. Frank O'Connor, Walworth Co., Boston.

"Crucible Melting," by G. K. Eggleston, Detroit Lubricator Co., Detroit.

Gray Iron Shop Course

Session 1—*"Cupola Practice."* Discussion leader: Donald J. Reese, International Nickel Co., Inc., New York.

AFTERNOON

Plant Visitation

Cincinnati Milling Machine Co.

EVENING

Malleable

Dinner and roundtable conference. Discussion on current practices.

Materials Handling

"Mold Equipment," by W. R. Jennings, John Deere Tractor Co., Waterloo, Iowa.

"Some Tests on Effectiveness of Water Under High Pressure for Cleaning Castings," by R. Webster, Hydroblast Co., Chicago.

Nonferrous

"Effects of Aluminum and Antimony on Physical Properties of Red Cast Brass (85-5-5-5)," by H. B. Gardner and C. M. Saeger, Jr., national bureau of standards, Washington.

"High-Conductivity Copper Castings," by A. B. Kinzel, Union Carbide & Carbon Research Laboratories, New York.

Annual business meeting of nonferrous division.

Lecture Course

Session 1—*"The Microscope in Elementary Cast Iron Metallurgy,"* by R. M. Allen, metallurgical consultant, Bloomfield, N. J.

Tuesday, May 16

MORNING

Gray Iron Shop Course

Session 2—*"Production of Uniform Dense Structures in High Test and Alloy Iron Castings,"* by M. A. Scott, Greenlee Foundry Co., Chicago.

Malleable

"Effects of Manganese on Second Stage Graphitization," by D. P. Forbes, Gunite Foundries, Rockford, Ill.

"Hydrogen in Solid White Cast Iron," by H. A. Schwartz and G. M. Guiler, National Malleable & Steel Castings Co., Cleveland.

Gray Cast Iron

"A Scientific Approach to a Foundry Problem," by L. A. Danse, Cadillac Motor Car Co., Detroit.

"60,000-Pound Cupola Iron," by E. L. Roth, Motor Casting Co., Milwaukee.

"Castings for the British Gas Industry," by F. Whitehouse, Newton, Chambers & Co., Ltd., Chapeltown, England. (Exchange paper of Institute of British Foundrymen.)

Nonferrous

"The Foundry and Metallurgical Science," by M. G. Corson, New York.

"Influence of Pouring Ladles on Quality of Red Brass," by R. W. Parsons, Ohio Brass Co., Mansfield, O.

Apprentice Training

"Apprentice Training," by Herman K. Ewig, Cincinnati Milling Machine Co., Cincinnati.

"Foundry Apprenticeship," by M. J. Gregory, Caterpillar Tractor Co., Peoria, Ill.

NOON

Nonferrous

Luncheon and roundtable meeting.

(Continued on Page A8)

"10 MINUTES AGO
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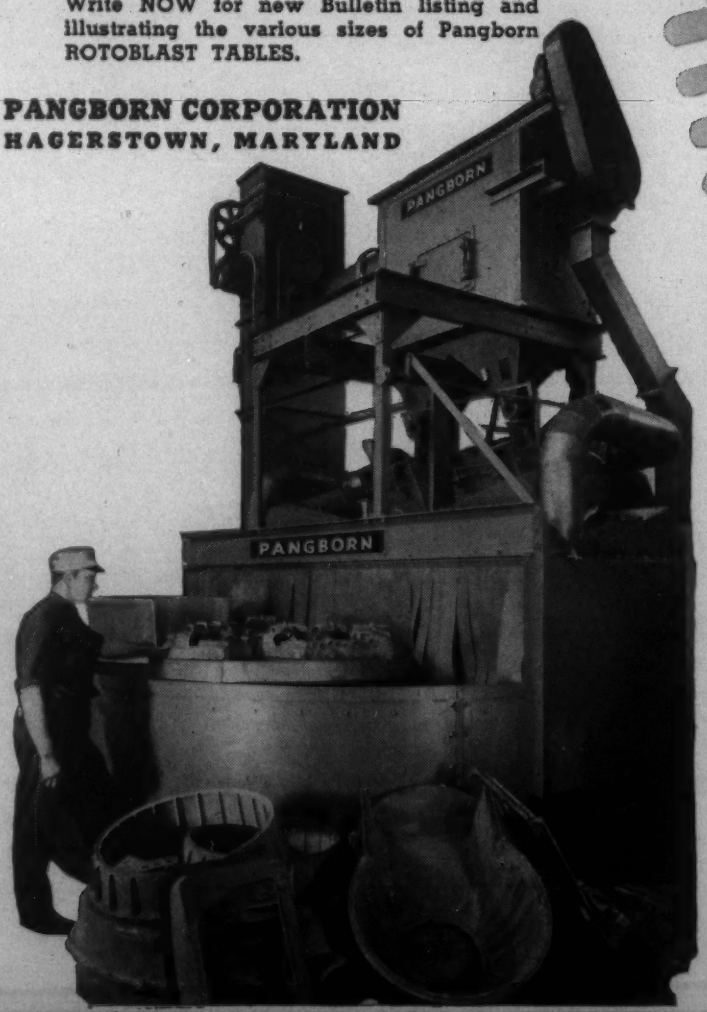

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(Continued from Page A7)

AFTERNOON

Safety and Hygiene

"Establishment of a Safety and Hygiene Program in a Small Foundry," by P. E. Rentschler, Hamilton Foundry & Machine Co., Hamilton, O.

"The Open House and Public Relations," by W. H. Doerfner, Saginaw Malleable Iron division, General Motors Corp., Saginaw, Mich.

Castability of Metals

"Castability of Cast Steel," by C. H. Lorig and E. C. Kron, Battelle Memorial Institute, Columbus, O.

"Effects of Superheating on Castability and Physical Properties of Gray Iron," by N. A. Ziegler and H. W. Northrup, Crane Co., Chicago.

"Measurement of the Fluidity of Aluminum Alloys," by L. W. Eastwood, Aluminum Co. of America, Cleveland.

"Malleable Iron Castability Tests," by E. J. Ash, University of Michigan, Ann Arbor, Mich.

Lecture Course

Session 2—*"The Microscope in Elementary Cast Iron Metallurgy,"* by R. M. Allen, metallurgical consultant, Bloomfield, N. J.

EVENING

Refractories

"Plastic Cupola Patching," by R. E. Wilke, John Deere Tractor Co., Waterloo, Iowa.

"Refractories in the Steel Foundry," by A. V. Leun, Bethlehem Steel Co., Bethlehem, Pa.

Time Study

"Practical Approach to Motion and Time Study," by G. J. Stegemerten, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Wednesday, May 17

MORNING

Gray Iron Shop Course

Session 3—*"Cupola Refractories and Figuring Mixes."* Discussion leader: J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.

Gray Iron

"Rapid Temperature Measurements of Cast Iron with an Immersion Thermocouple," by F. Holtby, University of Minnesota, Minneapolis.

"Copper-Aluminum-Silicon Alloy Additions to Cast Iron," by V. H. Schnee and T. Barlow, Battelle Memorial Institute, Columbus, O.

"Influence of Undercooling on the Graphite Pattern of Gray Iron," by R. Schneidewind and C. D'Amico, University of Michigan, Ann Arbor, Mich.

Foreman and Apprentice Training

"Foundry Apprentice Training—An Essential to Foreman Training," by A. P. Luebke, Fairbanks, Morse & Co., Beloit, Wis.

"A Foundrymen's Approach to Foreman Training," by W. G. Conner, Jr., Walworth Co., Greensburg, Pa.

Steel

"High Alloys Steel Castings for Heat and Corrosion Resistance," by James Corfield, Michigan Steel Castings Co., Detroit.

Report of committee on impact tests.

Report of committee on radiography: *"Gamma Ray Radiographic Standards of U. S. Navy for Steel Castings for Pressure Service,"* by N. A. Kahn, New York Navy Yard.

"Copper as an Alloying Element in Some Cast Steels," by C. T. Greenidge and C. H. Lorig, Battelle Memorial Institute, Columbus,O.

Sand Research

"Properties of Resin Bonded Cores," by Emile Pragoff, Jr., Hercules Powder Co., Wilmington, Del.

"Hot Strength and Collapsibility of Foundry Sands," by H. W. Dietert and E. E. Woodliff, Harry W. Dietert Co., Detroit.

Annual Business Meeting

Election of officers, Committee reports, Board of awards lecture.

(Continued on Page A10)

REFRACTORIES

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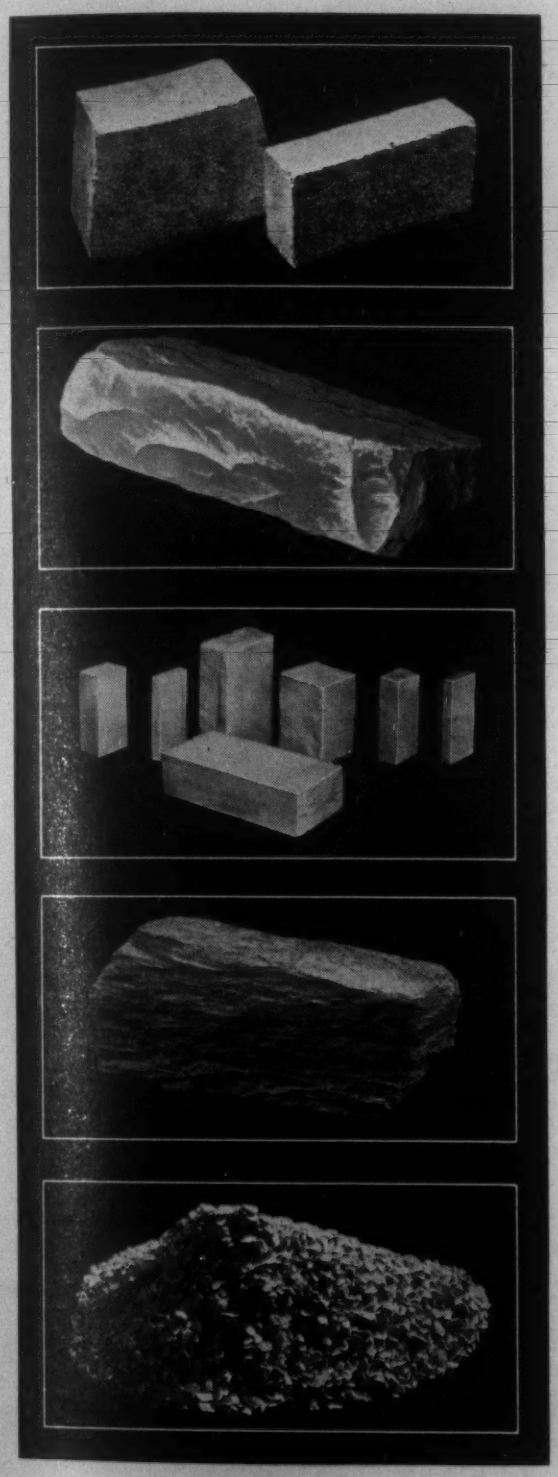

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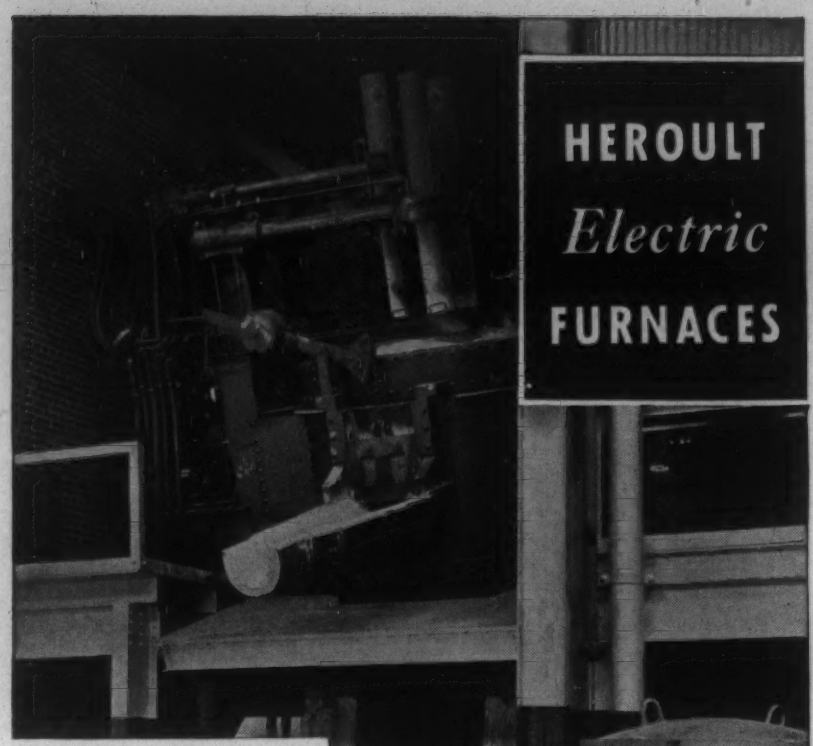

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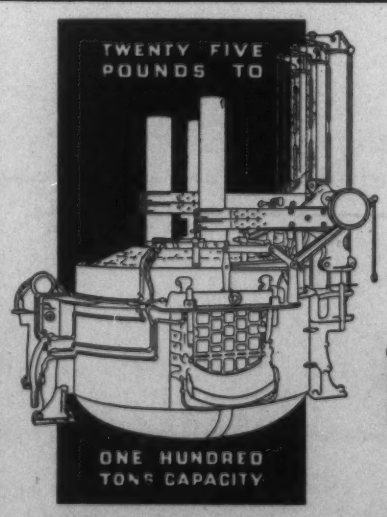

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(Continued from Page A8)

AFTERNOON

Steel

"A Rapid Method for Determining Carbon in Plain Carbon Steels for Control Purposes," by H. H. Blosjo, Minneapolis Electric Steel Foundry, Minneapolis.

"A Discussion on Steel Castings Having High Mechanical Properties," by George Delbart, Societe Francaise de Constructions Mecaniques, Paris, France. Exchange paper of Association Technique de Fonderie De France.

Report of committee on heat treatment. *"Synthetic Bonded Steel Molding Sands,"* by C. W. Briggs, Steel Founders' Society of America, Cleveland, and R. E. Morey, naval research laboratories, Anacostia, D. C.

Report of committee on coupon tests.

Sand Research

"Elements of Petrographic Study of Molding Sands," by R. E. Grim, Illinois geological survey, Urbana, Ill.

"Mineral Composition and Textures of the Clay Grade of Molding Sand," by C. E. Schubert, University of Illinois, Urbana, Ill., and R. E. Grim, Illinois geological survey, Urbana, Ill.

Report of sand research committee.

Foundry Costs

"Molding Costs," a committee report.

"Melting Costs," a committee report.

Lecture Course

Session 3—*"The Microscope in Elementary Cast Iron Metallurgy,"* by R. M. Allen, metallurgical consultant, Bloomfield, N. J.

EVENING

Annual Dinner

Thursday, May 18

MORNING

Gray Iron Shop Course

Session 4—*"Cupola Operation,"* by John Lowe, Lansing, Mich.

Steel—Symposium on Melting Practices

"Acid Electric," by W. G. Finster, Reading Steel Castings division, American Chain & Cable Co., Reading, Pa.

"Basic Electric," by C. W. Briggs, Steel Founders' Society of America, Cleveland.

"Basic Open Hearth," by J. W. Porter, American Steel Foundries, East Chicago, Ind.

"Acid Open Hearth," by W. C. Harris, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

"Converter," by F. B. Skeates, Link-Belt Co., Chicago.

"Induction Furnaces," by G. F. Landgraf, Lebanon Steel Foundry, Lebanon, Pa.

Gray Iron

"Influence of Composition on Physical Properties of Gray Iron," by R. G. McElwee, Vanadium Corp. of America, Detroit, and R. Schneidewind, University of Michigan, Ann Arbor, Mich.

"Some Factors in Hardening and Tempering Gray Cast Iron," by V. A. Crosby, G. A. Timmons and A. J. Herzig, Climax Molybdenum Co., Detroit.

"Effects of Heat Treatment on Combined Carbon and Physical Properties of Cast Iron," by S. C. Massari, Association of Manufacturers of Chilled Car Wheels, Chicago.

Pattern Making

"Some Pattern Making Problems," by J. A. Kolb, Caterpillar Tractor Co., Peoria, Ill.

NOON

Gray Iron

Gray iron division luncheon.

Steel

Steel division luncheon and roundtable. Discussion topics: "Deoxidizers;" "Reduction of Silicon from Slag."

AFTERNOON

Plant Visitation

Hamilton Coke & Iron division, American Rolling Mill Co., Hamilton, O.

Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Save the Surface

Graham (page MA 302 R 2) mentions a roll-swaging method for making a little tube from a big one that allows large reduction and avoids damaging the surfaces.—H.W.G.

Dry Ice Pack

To prevent buckling from thermal expansion during welding, Bailey (page MA 284 R 7) packs the parts to be welded, save for the seam itself, in dry ice.—H.W.G.

He Who Hesitates Is Lost

Friedman (page MA 271 R 7) comments that in hot pressing of non-ferrous metals, once flow is started it can be readily kept up, but any let-down in motion is fatal.—H.W.G.

Welding Carbon-Molybdenum Steel Piping

Welded C-Mo steel piping has been used successfully in the modern high-pressure, high-temperature, steam-electric generating plants for carrying steam at 900-1400 lbs. per sq. in. and 900-1100 deg. F. Most C-Mo steel piping installed to date has been arc welded, using a specially designed joint, with the electric preheating coils placed around pipe ends; the preheat temperature is maintained during arc welding by thermocouple controls. Small beads are deposited, using 1/8 in. and 5/32 in. diam. electrodes, and it is common practice to chip out about half of each bead laid to assure absence of unwanted inclusions in the weld. After completion of weld, it is stress-relieved by slow heating with the electric coils to a temperature of 1100-1200 deg. F., followed by slow cooling.

Because of the long time and many beads required to arc weld these joints, several piping fabricators have felt that possibly oxyacetylene welding might offer a means of expediting the operation and lowering costs. Accordingly, suitable C-Mo gas welding rods have been developed. Results of field tests made to date are most promising (page MA 280 R 7).—E.V.D.

Welded Oil Well Casing

Welded oil well casing installed in the well costs less than similar threaded-and-coupled casing. If all the 100,000,000 feet of casing run per year were welded instead of mechanically joined, it is figured that this would produce a saving of over $5,000,000 to the petroleum industry, or a half-cent per barrel in the total cost of oil production. In addition, a joint efficiency of 100% is easily secured by welding on casing up to and including Grade C, whereas the average joint efficiency of threaded-and-coupled casing does not exceed 60%. With welded casing, the manual operations of making the joints are reduced to utmost simplicity and this added safety feature makes it very popular with drilling crews. Welded casing joints are also of advantage in cementing jobs and less clearance is required between casing strings. It has been predicted that as soon as an efficient casing welding service is developed in all oil fields, the welding of the major portion of all oil well casing will be standard practice (pages MA 282 R 7 and MA 284 R 9).—E. V. D.

Plastics Plus Metals

Hanke (page MA 311 R 7) suggests incorporating magnetic particles into thermoplastics under the influence of a magnetic field so as to orient the particles. On chilling, the particles are retained in their position and impart directional properties. It isn't obvious what such a combination would be good for, but who can tell?—H.W.G.

Sheet and Bar by Direct or Continuous Casting

Outstanding for its thorough and up-to-date treatment is Mort's review (page MA 265 L 5) of processes for the production of sheet, rod, tubing, etc., direct from the molten metal. Progress towards commercial application of any of the existing methods has been slow and discouraging, the problem of controlling the interdependent factors of cooling rate and speed of "draw" still being formidable. However, one large American copper producer is now making continuous-cast billets, so the outlook for important application of this art may not be completely dark.—F.P.P.

Graphite-Copper Castings

Difficulties in producing self-lubricating bearings of the graphitic bronze or graphitic copper types by ordinary melting methods have been so great that best American practice has depended on powder metallurgy for making such composites. Comes now a German method (page MA 269 R 9) that comprises melting the copper with 20-25 per cent graphite in a high frequency furnace to provide thorough mixing, and pouring into metal molds to obtain quick freezing and avoid segregation. The impact properties are still suspect, but the idea sounds interesting anyway.—F.P.P.

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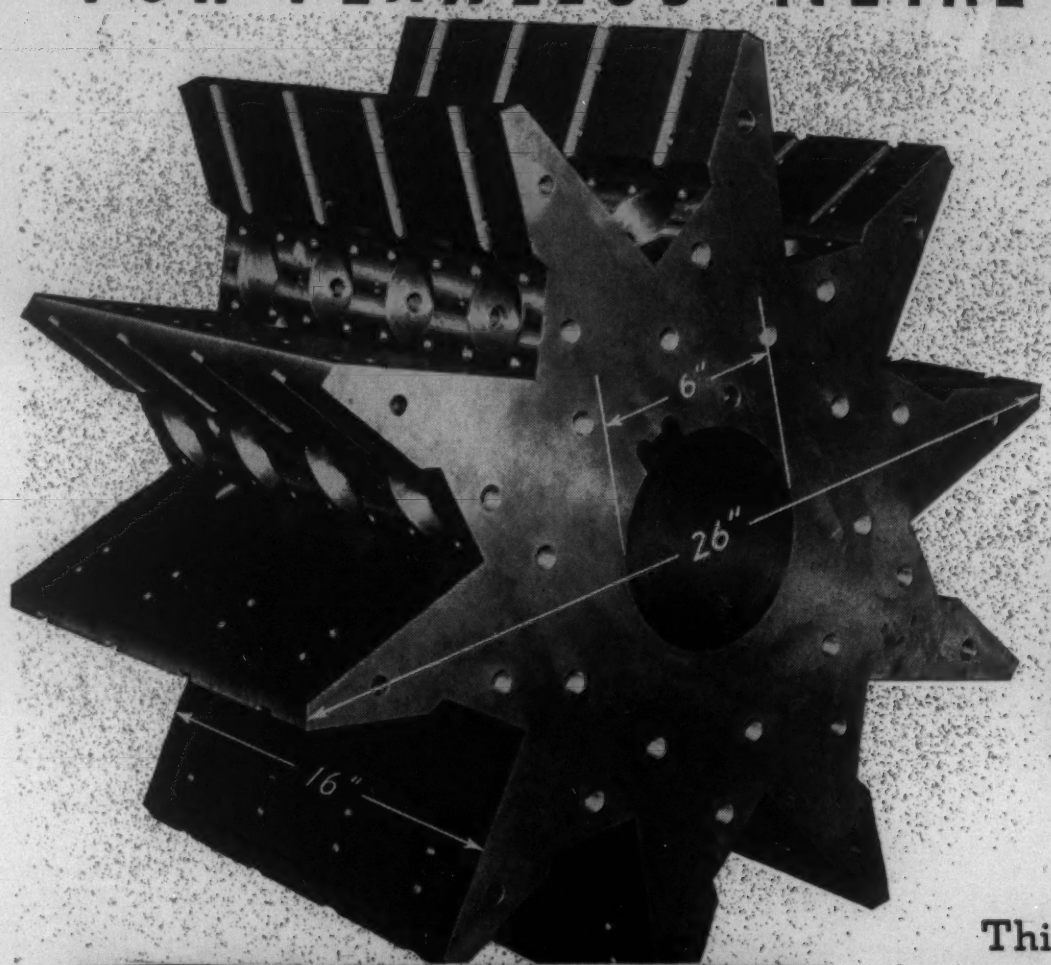

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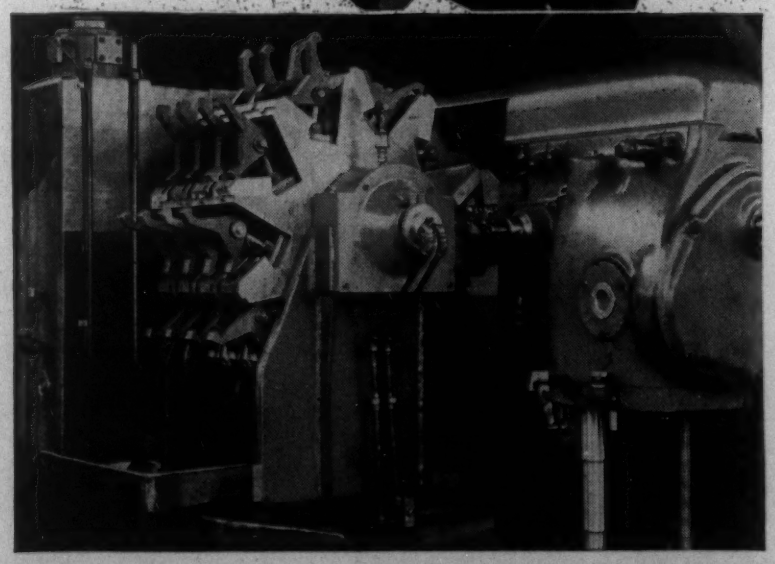

This intricate rotary drum type fixture for a Cincinnati Milling Machine Company's Special Profile Miller was cast in *Meehanite Metal* to insure a uniformly solid casting, free from shrinks and blow-holes and readily machinable. The unmachined casting weighed 1645 pounds, contained heavy sections up to 17 inches,—proved to be entirely flawless when subjected to the many machining operations necessary.

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General Foundry & Mfg. Company	Flint, Mich.
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Vulcan Foundry Company	Oakland, Calif.
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Rosedale Foundry & Machine Co.	Pittsburgh, Pa.
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Valley Iron Works	St. Paul, Minn.
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Meehanite Metal Corporation	Pittsburgh, Pa.
Australian Meehanite Metal Co., Ltd.	Waterloo, N. S. W.

PREVIEW

of the Forty-Second Annual Convention of the

AMERICAN SOCIETY FOR TESTING MATERIALS

Atlantic City, N. J.

JUNE 26 to 30, 1939

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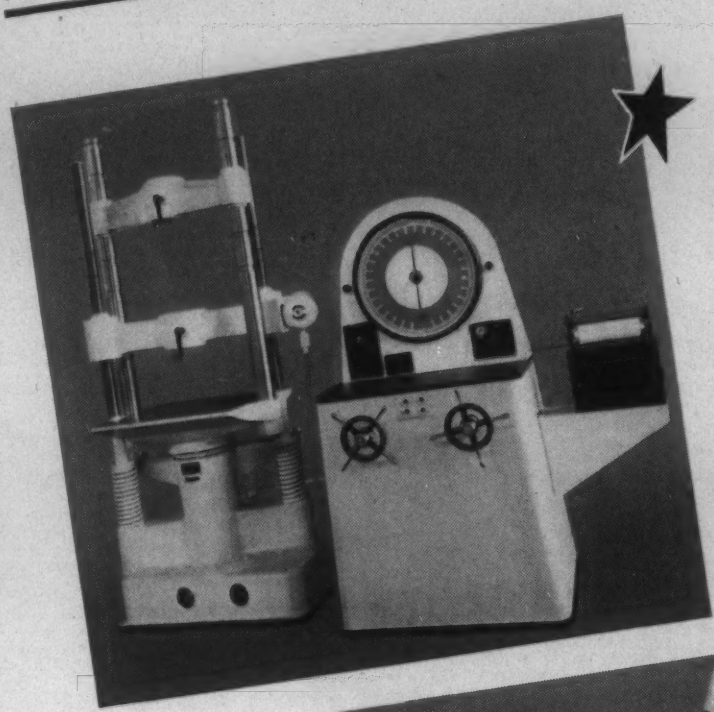

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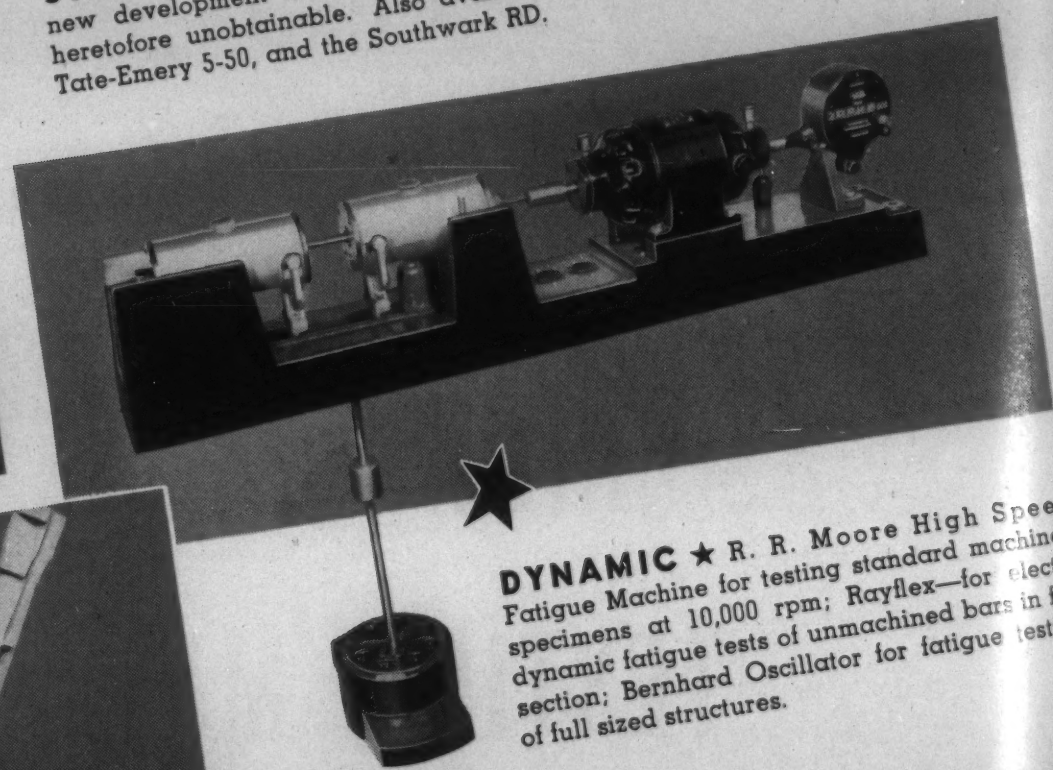
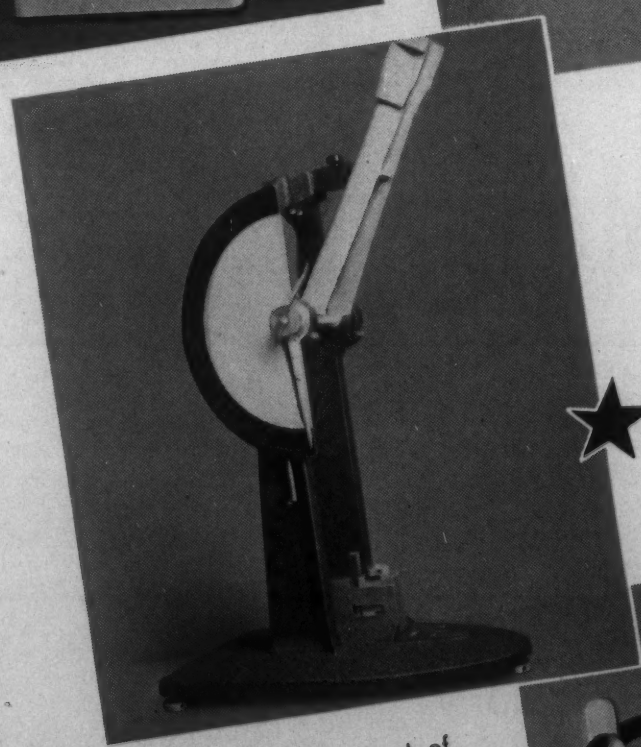
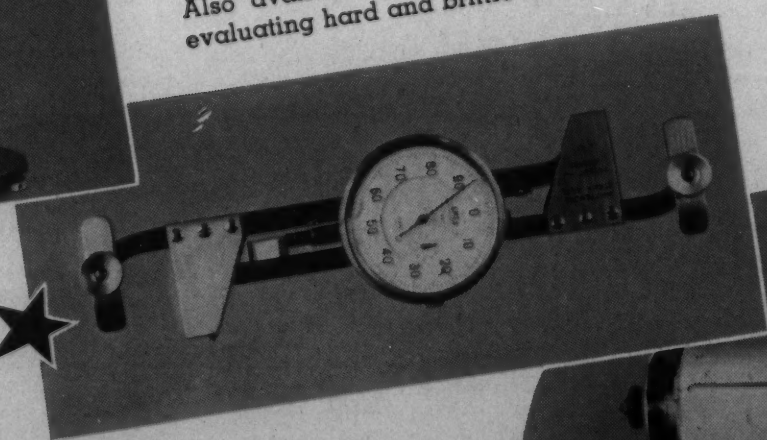


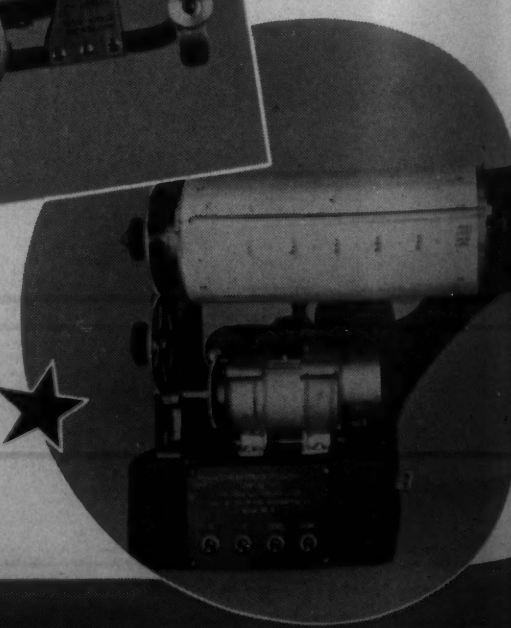
DYNAMIC ★ R. R. Moore High Speed Fatigue Machine for testing standard machined specimens at 10,000 rpm; Rayflex—for electro dynamic fatigue tests of unmachined bars in full section; Bernhard Oscillator for fatigue testing of full sized structures.



IMPACT ★ A notched bar machine of unexcelled precision designed for testing materials requiring low energy to fracture. Also available is the Carpenter Torsion Impact machine for evaluating hard and brittle materials.



STRAIN MEASURING ★ A host of various types of strain measuring devices for analysis of structures under static and live loads. These include such well known types as Huggenberger, Whittemore, de Forest, Carbon Resistor Telemeter and Inductor Telemeter.



STRESS-STRAIN RECORDING ★ The Southwark-Templin high magnification recorder which automatically plots complete test records at full testing speed with such precision and ease that they are used on a routine basis.

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Introduction

The 42nd annual meeting of the American Society for Testing Materials—always an outstanding technical gathering for all interested in engineering materials—is to be held at Chalfonte-Haddon Hall, Atlantic City, June 26 to 30.

A number of rather significant items of interest will characterize this year's convention. One is that it will be the first meeting in Atlantic City, accompanied by an Exhibit of Testing Apparatus and Related Equipment. Further details of this are given in another page.

Another item of interest, pointed to by The Society, is the unusual number of round table discussions and Symposiums. One of special interest is a round table discussion on "Quantitative Spectrography," scheduled for the morning, afternoon and evening, June 29. Mention should also be made of the one on "Effect of Sub-Atmospheric Temperatures on the Properties of Metals."

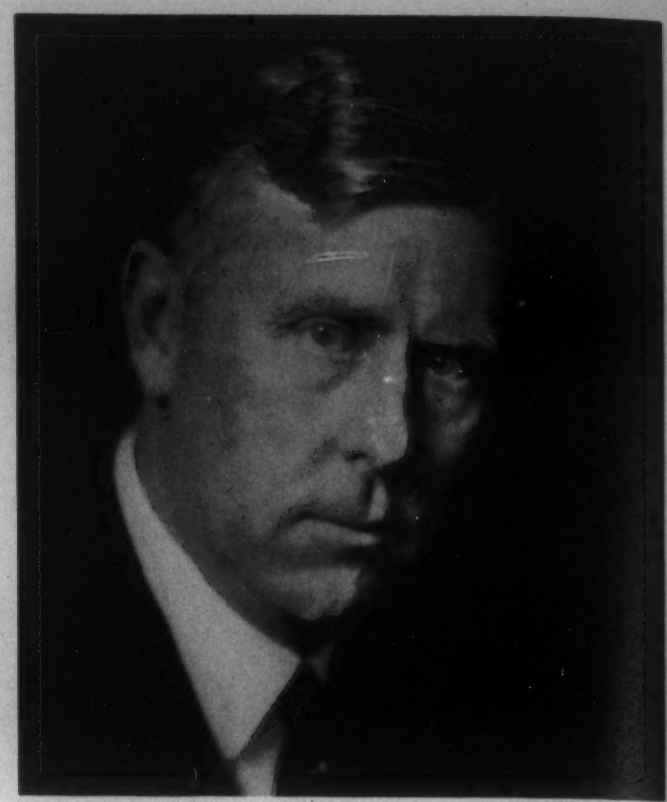
The opening session—Tuesday, June 27, 10:30 A.M.—will be featured by the annual address by the President of the Society, and the recognition of the 40-yr. members.

The Edgar Marburg Lecture, the 14th, will be delivered on Wednesday, June 28, at 4 p.m. by Prof. H. F. Moore, University of Illinois, a widely known authority on fatigue and other subjects. His topic this year is "Stress, Strain and Structural Damage."

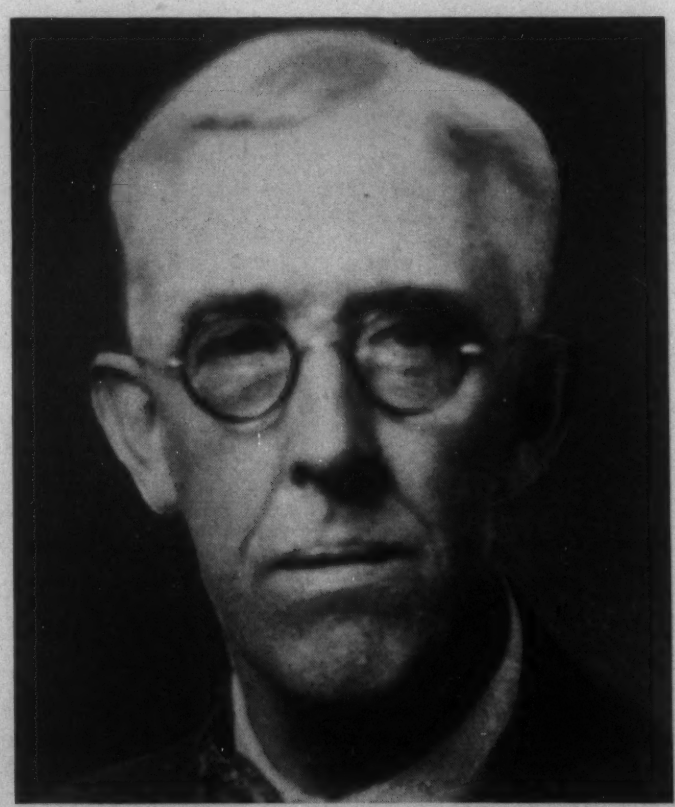
Following the lecture, the 13th award of the Charles B. Dudley Medal will be made to R. W. Carlson, associate professor of civil engineering, Massachusetts Institute of Technology, for his paper at last year's convention on "Drying Shrinkage of Concrete as Affected by Many Factors."

Including the round-table discussion there will be 23 technical sessions in all. Those relating to metals and the metal industry will be found on other pages.

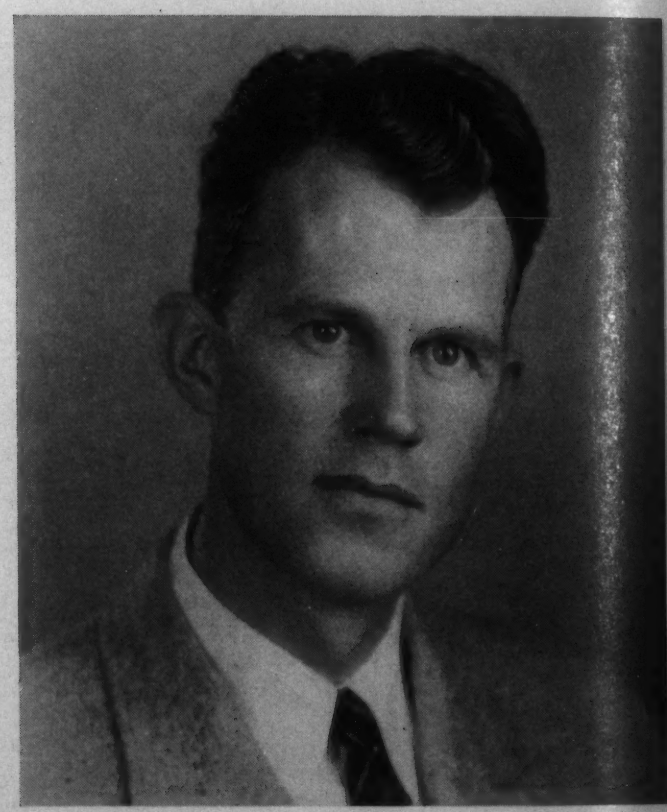
H. H. Morgan—*President*



G. E. F. Lundell—*Vice President*



H. F. Moore—*Lecturer*



R. W. Carlson—*Medalist*

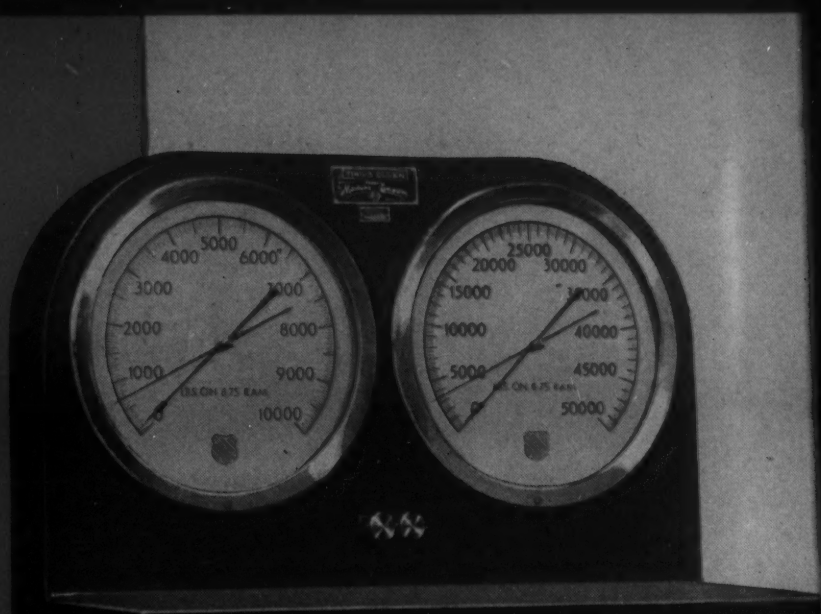
The Technical Program

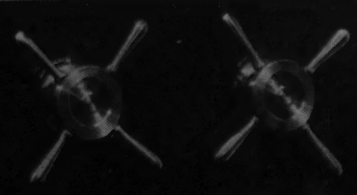
The technical sessions commence on Tuesday morning, June 27, and continue through Friday, June 30. On two occasions provision is made for triple simultaneous sessions on topics on which there can be little conflict of interest. This is made necessary to include adequate provision for presentation of all the papers.

The tentative technical program, which only includes sessions devoted to metals and related subjects, follows:

Limited Funds?

HERE'S YOUR MACHINE!





★ Visit Booth 32 at the Atlantic City Meeting of the American Society for Testing Materials. . . . Week of June 28th. See for yourself the compactness and rugged construction of the Olsen L-Type Hydraulic Testing Machine. You'll find it on exhibition there . . . and we welcome your most thorough inspection.

THE OLSEN L-TYPE HYDRAULIC TESTING MACHINE . . . for Foundries, Vocational Schools, Small Colleges, Welding and Specialty Shops! Wherever funds for testing work are limited, this machine provides performance of highest efficiency. It is designed, engineered and built to Tinius Olsen standards throughout . . . and those are standards which have been foremost in the field for 59 years! Built for extreme compactness, it permits fast, accurate work while occupying the minimum of floor space. The price is a boon to cramped budgets. Promote the efficiency of your production with this quality machine! Get the facts! They're yours simply for the asking . . . write today.

Symbol of the finest in testing and balancing machines . . . since 1880

Features

OF THE OLSEN L-TYPE HYDRAULIC TESTING MACHINE:

1. **20,000 TO 60,000 LB. CAPACITY.** Overall height, 63½". Floor space, 10 sq ft. Approximate net weight, 2,000 lbs.
2. **INDICATING GAUGES IN INSTRUMENT PANEL.** Isolated from loading cylinder.
3. **CYLINDER IN BASE.** Lowers center of gravity.
4. **CONSTANT SPEED, GEAR-TYPE PUMP.** Quiet and efficient. No pulsation.
5. **DIRECT FLEXIBLE COUPLING CONNECTION OF MOTOR TO PUMP.** Eliminates noise and drive slippage.
6. **PUSH BUTTON STARTERS.** Standard equipment.
7. **FOUR COLUMN RODS.** Makes sturdy construction.
8. **CROSSHEAD ADJUSTING CRANK.** Easy to reach.
9. **STURDY OIL RESERVOIR.** Bolted to base directly under pump.
10. **SEPARATE CONTROLS FOR LOADING AND UNLOADING.**

TINIUS OLSEN TESTING MACHINE COMPANY

500 NORTH TWELFTH STREET . . . PHILADELPHIA, PA.

Tuesday, June 27
Afternoon Session

Subject—Iron

Report of Committee A-2 on Wrought Iron, by C. B. Bryant, Chairman.

Report of Committee A-3 on Cast Iron, by W. H. Rother, Chairman.

"Mechanical Properties of High-Strength Cast Iron," by Jasper O. Draffin and W. Leighton Collins, University of Illinois.

"Influence of Chromium on the Oxidation Resistance of Cast Iron," by Charles O. Burgess, Union Carbide & Carbon Research Laboratories, Inc.

Report of Committee A-7 on Malleable-Iron Castings, by E. K. Smith, Chairman.

"The Resistance of High-Silicon Malleable Iron to Drilling," by H. A. Schwartz, National Malleable & Steel Castings Co., R. C. Kasper and N. E. Mertz, Case School of Applied Science.

"The Relation of Carbon Nodule Size and Tensile Properties of Malleable Cast Iron," by H. A. Schwartz, National Malleable and Steel Castings Co., H. J. Schindler and J. F. Elliott, Case School of Applied Science.

Report of Sectional Committee A-21 on Specifications for Cast-Iron Pipe and Special Castings, by T. H. Wiggin, Chairman.

Tuesday, June 27
Evening Session

Round-Table Discussion of Effect of Sub-Atmospheric Temperatures on the Properties of Metals

"Sub-Size Charpy Relationships at Sub-Zero Temperatures," by H. Habart and W. J. Herge, National Tube Co.

"Factors Affecting Notched-Bar Impact Tests of Steel at Low Temperatures," by Walter Crafts and John J. Egan, Union Carbide & Carbon Research Laboratories, Inc.

Wednesday, June 28
Morning Session

Subject—Fatigue, Corrosion

Report of Research Committee on Fatigue of Metals, by H. F. Moore, Chairman.

"Fatigue Tests of Wire," by C. P. Wampler, A. O. Smith Corp. (Formerly University of Illinois), and N. J. Alleman, University of Illinois.

"Fatigue Strength of Machined Forgings 6 to 7 in. in Diameter," by O. J. Horger and H. R. Neifert, The Timken Roller Bearing Co.

"Fatigue Machines for Testing Structural Units," by R. L. Templin, Aluminum Co. of America.

Report of Committee A-5 on Corrosion of Iron and Steel, by W. H. Finkeldey, Chairman.

Report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys, by T. S. Fuller, Chairman.

Paper Appended:

"Chemical Removal of Corrosion Products in the Determination of the Corrosion Rate of Zinc," by E. A. Anderson and C. E. Reinhard, The New Jersey Zinc Co.

"Atmospheric Corrosion of Non-Ferrous Metals and Alloys," by C. W. Borgmann, University of Colorado.

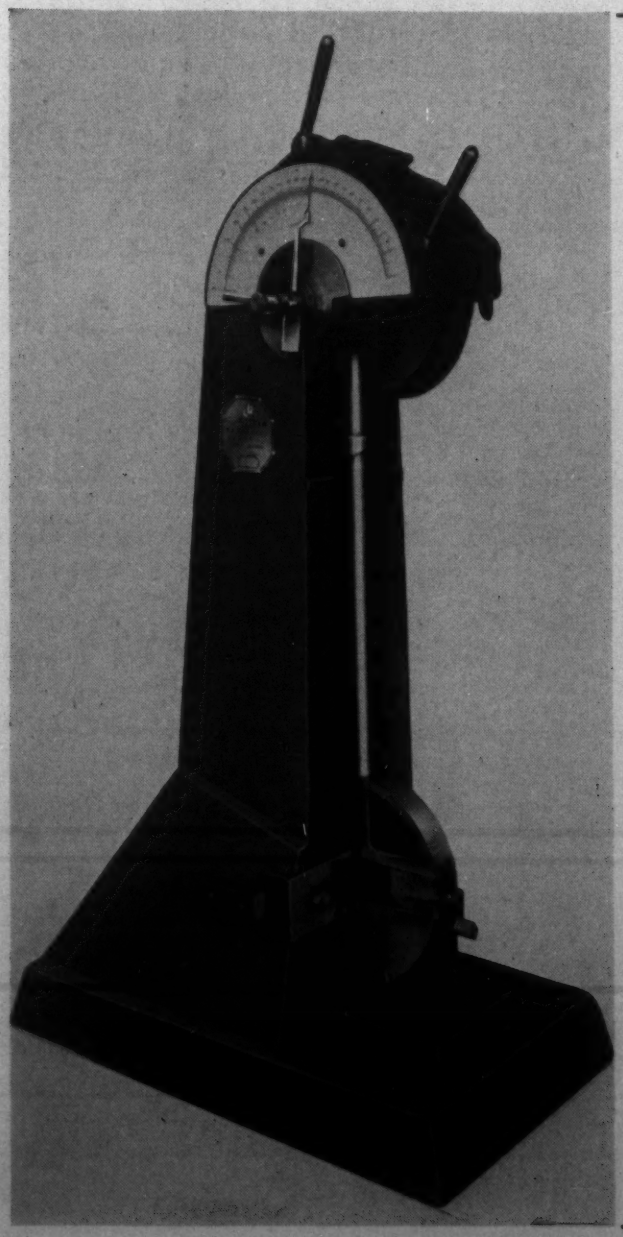
Report of Joint Committee on Exposure Tests of Plating on the Non-Ferrous Metals, by William Blum, Chairman.

Wednesday, June 28
Afternoon Session

Subject—Lecture and Award of Medal

Fourteenth Edgar Marburg Lecture: *"Stress, Strain and Structural Damage,"* by Prof. H. F. Moore.

(Continued on page A 12)



The Machine That Made Impact Testing Popular

Riehle Precision Combination Izod–Charpy–Tension Impact Tester

Nearly Sixty Sold During Past Few Years

RIEHLE TESTING MACHINE DIVISION

American Machine and Metals Inc.
EAST MOLINE, ILLINOIS

ASTM Exhibit Booth Number 18

It Gives a Picture of the Wire

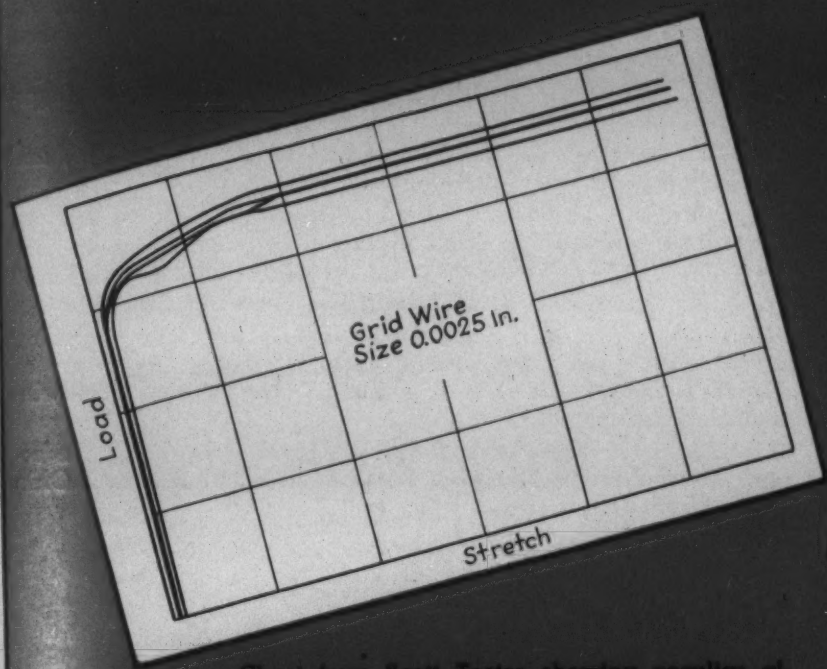


Chart from Scott Tester showing peculiar alternating characteristics of good ratio grid wire beyond yield point.

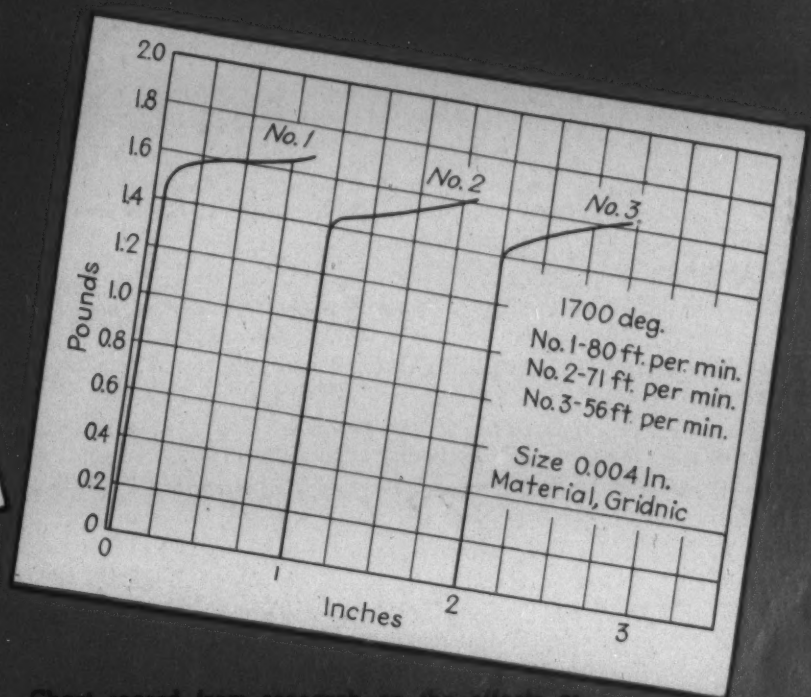


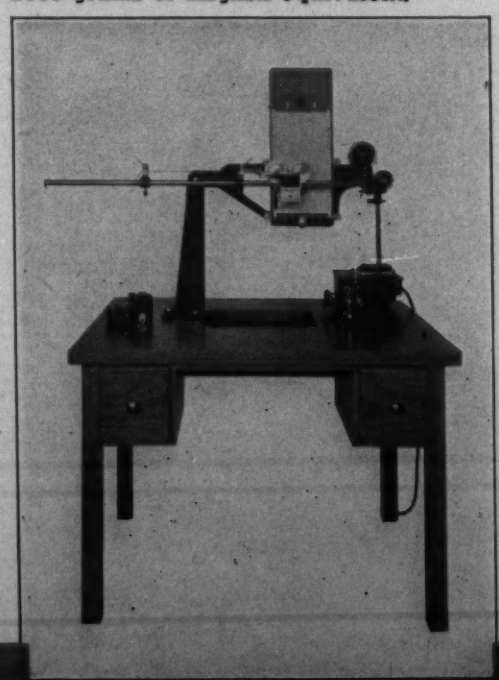
Chart record from research on the effects of conveyor speeds during heat-treatment of special-purpose wire.

Scott Incline Plane Serigraph Automatically Records Entire Action of Wire Under Test.

The Scott Incline Plane Serigraph will test tensile and elongation, hysteresis or fatigue at any predetermined point of load for any number of repeated cycles, and the test may be carried to breaking at any time desired. It produces a permanent chart-record of elongation, recovery, permanent loss, yield strength, ultimate tensile strength—of every phase of the testing.

The machine is sufficiently delicate for research testing, yet is substantial enough to withstand the wear and tear of daily routine work. For instance, the inclined plane—the heart of the machine—is of hardened stainless steel, polished to a mirror finish, and the wheels of the testing carriage are mounted on sapphire jewel bearings which operate with the least possible amount of friction. The Scott Tester is so simple to operate that accurate, dependable results may be obtained by ordinary operators.

(Below)—Scott Incline Plane Serigraph IP2. Furnished in capacities from 25 to 2000 grams or English equivalent.



Many manufacturers are now using Scott Testers to get a complete "picture" of the wire they make and use for fabric, screens, filter cloth, brake bands, and many other purposes. For further details, send for a reprint of an article just published in "Metals and Alloys."

HENRY L. SCOTT CO.
PROVIDENCE, R. I.

Makers of wire and other testing equipment with capacities to 2,000 lbs.

See It In Action at Booth 46, ASTM Show

Award of Charles B. Dudley Medal to Roy W. Carlson, Massachusetts Institute of Technology.

Wednesday, June 28
Evening Session

Subject—Radiography, Magnetic Testing, Metallography

Report of Committee E-4 on Metallography, by L. L. Wyman, Chairman.

Paper Appended:

"Application of Color Photography to Metallographic Work," by R. P. Loveland, Eastman Kodak Co.

Report of Committee E-7 on Radiographic Testing, by H. H. Lester, Chairman.

"The Use of Radiography in the Development of Castings for Mass Production," by Don M. McCutcheon, Ford Motor Co.

"Factors Governing Practical Sensitivity of Radiographic Tests," by H. H. Lester, Watertown Arsenal.

Modern Testing of Aircraft Materials:

"Correlation of Some Mechanical Tests of Aluminum Alloys with X-ray Tests," by Tom A. Triplett, Triplett & Barton, Inc., and W. Lavern Howland, California Institute of Technology.

"Some Mechanical Tests of Aluminum Alloys 14ST and 24ST," by W. B. Mechling and S. S. Jack, California Institute of Technology.

Report of Committee A-6 on Magnetic Properties, by Thomas Spooner, Chairman.

"Magnetic Analysis—Modern Methods and Applications," by Theodor Zuschlag, Magnetic Analysis Corp.

Thursday, June 29
Morning Session

Subject—Steel Ferro-Alloys, Effect of Temperature

Report of Committee A-1 on Steel, by N. L. Mochel, Chairman.

"The Work-Brittleness Test," by H. W. Graham, Jones & Laughlin Steel Corp., American Iron and Steel Works..

Report of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, by Jerome Strauss, Chairman.

"The Alloy Casting Research Institute Test Block for Heat-Resisting Alloys; Its History, Selection and Utilization," by O. E. Harder, Battelle Memorial Institute.

"The Hastelloy Alloys, Their Physical and Corrosion-Resistant Properties," by F. G. McCurdy, Haynes Stellite Co.

Report of Sectional Committee B-36 on Standardization of Dimensions and Materials of Wrought-Iron and Wrought-Steel Pipe and Tubing, by H. H. Morgan, Chairman.

Report of Committee A-9 on Ferro-Alloys, by Charles McKnight, Chairman.

Report of Joint Research Committee of A.S.M.E. and A.S.T.M. on Effect of Temperature on the Properties of Metals, by N. L. Mochel, Chairman.

Thursday, June 29
Morning Session

Round Table—Spectrography

Round-Table Discussion on Quantitative Spectrography (To continue during the afternoon and evening.)

Thursday, June 29
Evening Session

Subject—Methods of Testing

Report of Committee E-1 on Methods of Testing, by W. H. Fulweiler, Chairman.

Paper Appended:

"Testing of Hydrometers," by E. N. Hurlburt, Taylor Instrument Cos.

Report of Sectional Committee Z-23 on Specifications for Sieves for Testing Purposes, by L. T. Work, Chairman.

"Tension Specimen Shape and Apparent Strength," by F. O. Anderegg, Owens-Corning Fiberglas, Royal Weller and B. Fried, Ohio State University.

"Rockwell Hardness of Cylindrical Specimens," by W. E. Ingerson, Bell Telephone Laboratories, Inc.

"Analysis of Rockwell Hardness Data," by R. L. Peek, Jr., and W. E. Ingerson, Bell Telephone Laboratories, Inc.

"Stress-Strain-Time Characteristics of Materials," by Glenn Murphy, Iowa State College.

"A Study of the Influence of Speed on the Torsion Impact Test," by O. V. Greene and R. D. Stout, The Carpenter Steel Co.

"Load Weighing and Load Indicating Systems, an Historical Account of Their Development with Particular Reference to Materials Testing Devices," by Chester H. Gibbons, Baldwin-Southwark Corp.

"Photoelastic Analysis of a Prestressed Beam," by F. O. Anderegg, Owens-Corning Fiberglas, Royal Weller and B. Fried, Ohio State University.

Friday, June 30
Afternoon Session

Subject—Non-Ferrous Metals

Report of Committee B-1 on Copper and Copper-Alloy Wires for Electrical Conductors, by J. H. Foote, chairman.

Report of Committee B-2 on Non-Ferrous Metals and Alloys, by E. E. Thum, Secretary.

Report of Committee B-5 on Copper and Copper Alloys, Cast and Wrought, by C. H. Greenall, Chairman.

Paper Appended:

"Nomenclature and Classification of Cast Copper and Copper-Base Alloys," by Sam Tour, Lucius Pitkin, Inc.

"Service and Life of Non-Ferrous Tubes in Petroleum Refining," by E. S. Dixon, The Texas Company.

Report of Committee B-6 on Die-Cast Metals and Alloys, by J. R. Townsend, Chairman.

Paper Appended:

"Magnesium Alloy Die Castings," by A. W. Winston, The Dow Chemical Co.

Report of Committee B-7 on Light Metals and Alloys, Cast and Wrought, by Sam Tour, Chairman.

Report of Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys, by Dean Harvey, Chairman.

"Spectral Emissivity (at 0.65μ) of Some Alloys for Electrical Heating Elements," by W. F. Roeser, National Bureau of Standards.

Report of Committee E-2 on Spectrographic Analysis, by H. V. Churchill, Chairman.

"The Spectrographic Analysis of Tin," by J. Warren Stewart, Carnegie Institute of Technology.

Report of Committee E-3 on Chemical Analysis of Metals, by G. E. F. Lundell, Chairman.

"The Determination of Silicon in Certain Aluminum Alloys Containing Silicides," by Thomas A. Wright and John Jicha, Lucius Pitkin, Inc.

Miscellaneous Business.

THE EXHIBITION

It is the custom of the A.S.T.M. to hold an exhibition of testing apparatus and related equipment every other year. The last one—one of the most successful ever held—was in June, 1937, at the annual convention at the Waldorf-Astoria Hotel in New York.

The one this year—the fifth—will occupy the Vernon and Garden Rooms in the Haddon Hall at Atlantic City. It will be

located close to the registration desks and members' lounge which is just outside these two rooms.

Previous exhibits have featured two special types of displays which are considered extremely valuable and which have been highly recommended—those sponsored by committees of the Society portraying various phases of their standardization and research work, and, second, displays of institutional, research and Governmental laboratories of special fabrication and technique. They are visited by many attending the convention.

One other development is of interest—a photographic exhibit and competition on the theme, "Testing and Research in Engineering Materials." The first one of this character was held in 1938 and its success has merited a repetition this year.

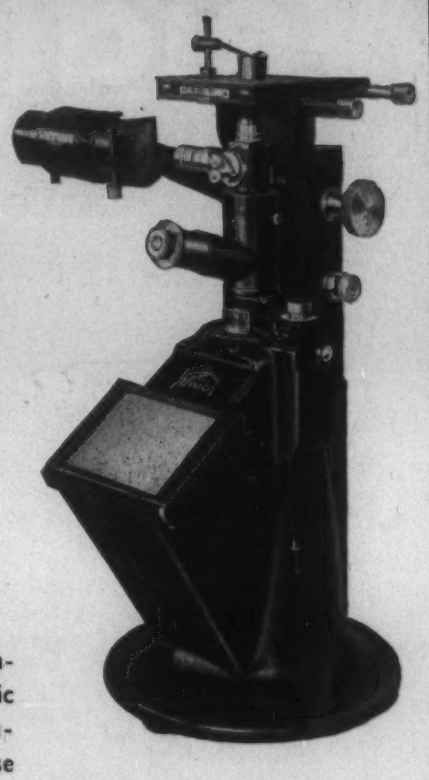
The official opening of the Exhibit will be noon, Monday, June 26.

A partial list of the exhibitors follows:

American Instrument Co.
Washington, D. C.
Baldwin-Southwark Corp.
Philadelphia, Pa.
Bausch & Lomb Optical Co.
Rochester, N. Y.
Christian Becker, Inc.
New York City
Brabender Corp.
Rochelle Park, N. J.
Central Scientific Co.
Chicago, Ill.
Eimer & Amend, Inc.
New York City
The Electric Tachometer Corp.
Philadelphia, Pa.
Federal Products Corp.
Providence, R. I.
Henry A. Gardner Laboratory
Washington, D. C.
Kimble Glass Co., Vineland, N. J.
Leeds & Northrup Co.
Philadelphia, Pa.
"Metals and Alloys"
New York City
National Carbon Co., Inc.
Cleveland, Ohio
Nurnberg Thermometer Co., Inc.
Brooklyn, N. Y.
Tinius Olsen Testing Machine Co.
Philadelphia, Pa.
Parr Instrument Co., Moline, Ill.
E. W. Pike & Co.
Elizabeth, N. J.
Radium Chemical Co., Inc.
New York City
Riehle Testing Machine Division,
American Machine and Metals,
Inc.....East Moline, Ill.
Rubicon Co.....Philadelphia, Pa.
George Scherr Co., Inc.
New York City
Henry L. Scott Co., Inc.
Providence, R. I.
C. J. Tagliabue Manufacturing
Co.....Brooklyn, N. Y.
Carl Zeiss, Inc...New York City

BUSCH METAPHOT

On Demonstration
at Booth 23

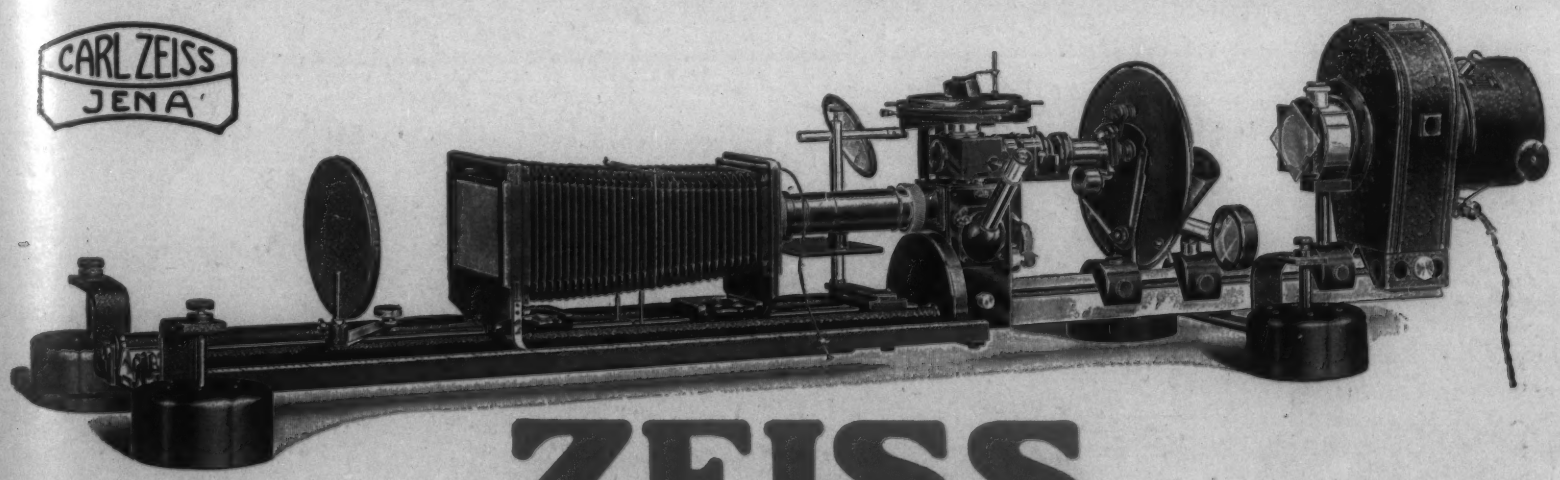


Also on exhibit:
Bore Inspection Telescope for internal inspection

Comparison Microscope for surface finish

Equipment for the preparation of metallographic specimens. Write for complete literature on these articles.

GEORGE SCHERR CO.
124 LAFAYETTE ST., NEW YORK



ZEISS

The Zeiss "Neophot" Metallograph is a universal apparatus for micro- and macro-photography, low power survey, bright field and dark field work with instantaneous change-over without disturbance of focus, and for use of polarized light to examine medium polished surfaces under high magnification. Simple yet stable design. Unexcelled optics. Easy to operate. Catalog MICRO 500-A156 upon request.

You are cordially invited to visit our Exhibit at the ASTM Convention at Atlantic City, Booths 16 & 17.

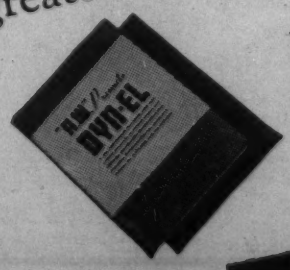
CARL ZEISS, INC., 485 FIFTH AVE., NEW YORK
728 So. Hill St., Los Angeles

"NEOPHOT" METALLOGRAPH

New Bus Cuts Dead Weight 1300 pounds

25-passenger bus built by BOYERTOWN AUTO BODY WORKS, Boyertown, Pa. Over-all length, bumper to bumper, approximately 25'; over-all width, 96". All structural sections are 18 gage Dyn-el.

With rolled structural sections of conventional steel, this 25-passenger bus would have a curb weight of 10,000 pounds. With formed structural sections of "A. W." Dyn-el, the curb weight is only 8,700 pounds—a saving of 1,300 pounds in dead weight . . . And with all its lightness this body of "A. W." Dyn-el high strength steel is stronger than a conventional body, and has greater resistance to shock, fatigue and corrosion.



The 48-page book, "A.W." Presents Dyn-el, gives full details of savings in weight and cost possible with this new high-strength, flat-rolled steel. Diagrams, tables and charts cover a wide range of tests and properties. To executives, this book gives a quick picture of performance and costs. To engineers, it gives complete fabricating and design properties and table of sizes and weights. We will be pleased to send you a copy.

DYN-EL

ALAN WOOD STEEL COMPANY

MAIN OFFICE AND MILLS, CONSHOHOCKEN, PENNA. : : SINCE 1826 : : DISTRICT OFFICES AND REPRESENTATIVES—Philadelphia, New York, Boston, Detroit, Los Angeles, Seattle, San Francisco, Houston, Roanoke, Buffalo, Pittsburgh, Cleveland, Chicago, Cincinnati, New Orleans, St. Paul, St. Louis, Montreal. PRODUCTS INCLUDE—"A. W." Rolled Steel Floor Plate : : "Swede" Pig Iron : : Billets—Blooms and Slabs : : Sheared Steel Plates : : Hot Rolled Sheets and Strip : : Steel Products also furnished in Copper and Alloy analyses.

Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Wear of Cast Iron

West and Hodgson (page MA 369 L 1) state that high P helps wear resistance, while Francis (page MA 369 R 2) says that a phosphide eutectic is very bad, since particles pull out to form a hard abrasive. Isn't it all a question of whether the service is such that the debris is trapped between mating surfaces?—H.W.G.

Quicker Than the Eye

Andrew (page MA 335 R 4) suggests that the graphitizing action of Ni is due to an unstable Ni carbide which breaks down. This is the sort of hypothesis that is hard to disprove, since its promulgator can postulate such a high degree of instability that its presence can't be caught by any sort of quench, so examination would have to be at the high postulated temperature of formation.—H. W. G.

Oxides

Elliss (page MA 336 R 1) alleges that yield strength is enhanced by presence of oxygen in steel, as he drops the yield strength by vacuum melting.—H.W.G.

Grain Size

Houdremont and Schrader (page MA 342 R 8) offer evidence that AlN plays a part in grain size control by Al. —H.W.G.

Cold-Rolled Malleable Iron

Improving the mechanical properties of malleable Fe by cold-rolling is said to be one result of an English investigator (page MA 339 L 9). White heart malleable is cold-rolled with light passes and proper annealing. Some useful industrial applications are claimed.—E.F.C.

High Frequency Heat Treatment

In newly developed German equipment for selective hardening of crankshafts by high frequency heat (page MA 344 R 3) 40 small crankshafts with 8 bearings each are treated per hr. Time for heating is 4 sec. and for quenching, 8 sec. Another one for large crankshafts is in operation.—E.F.C.

Welding of Aluminum

Welding provides an efficient means of making permanent leakproof joints and repairs on aluminum and aluminum alloy products. Fusion welding, in the form of torch and arc welding, and pressure welding in the form of spot, butt and seam welding are all used for these materials. Oxyhydrogen and oxyacetylene welding are more widely used than any other method. These processes are simple and rapid and can be applied to metal of any thickness.

The major developments in resistance welding of aluminum and its alloys have taken place just within the past few years. Nevertheless, it has already become an important fabricating process. In many cases, it has brought about reduced cost, high production and an improved product. Undoubtedly its use will continue to grow in the future (page MA 354 R 5).—E.V.D.

Lead and the Hardening Depth of Chilled Iron

The hardening depth of cast iron is changed by the presence of Pb, according to H. Bruhn, a German investigator (page MA 335 R 7). This was discovered by chance in a roll foundry. Because of contrary results, depending on the melting medium, the research was undertaken. The cause of the different effects of Pb is believed to lie in the residues present in iron, such as oxides and alloying elements.—E.F.C.

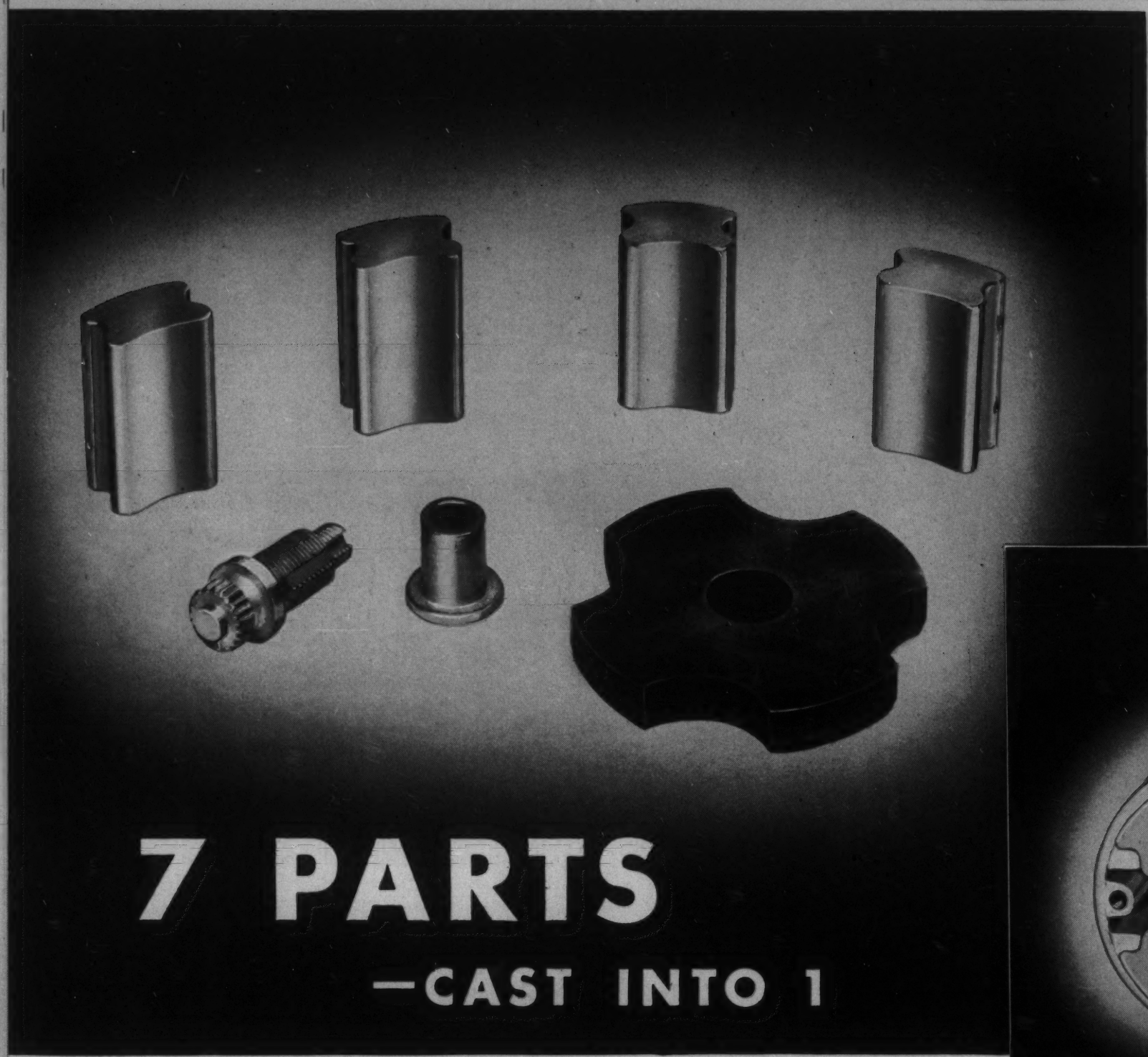
High Tensile Steels Lead

According to a survey (page MA 367 R 5) of the specific strength (strength divided by sp. gr.) of materials for aircraft, the low alloy, high tensile steels lead with elektron and duralumin a close second.—E.F.C.

German Wide Strip Mill

The Germans have developed a 2-pass universal rolling mill for rolling wide strip semi-continuously (page MA 339 L 8). The strip is returned by rollers for the return pass through the same 3-high universal stand which has at each side of it an auxiliary 2-high stand. Smaller initial and operating cost, less space than the usual continuous tandem mill, with easy accommodation to change in production rate are claimed.—E.F.C.

ZINC ALLOY DIE CASTINGS



7 PARTS
—CAST INTO 1

Assembly costs are greatly minimized with ZINC Alloy Die Castings—regardless of the complexity of design. But there are many instances where it is essential to assemble more than one metallic element in a single unit. Consider the economies of the above application where 7 inserts, having special properties, are cast into 1 piece.

1. ASSEMBLING—The magneto generator part (smaller photograph) calls for 4 pole pieces of soft steel, an aluminum-nickel disk, a bronze bushing, and a steel support stud. These elements (larger photograph) are inserted in the die casting die and a ZINC Alloy housing is cast around them. The result: 1 piece instead of 7.

2. MACHINING — Although the inserted elements require finishing beforehand, there is no machining done on the ZINC Alloy Die Cast housing itself, other than the simple tapping of holes.

3. ACCURACY—With the die casting process it is possible to place each insert accurately in its correct relative position in the housing. And the physical properties of the ZINC Alloys are such that ample strength and permanence are insured in the securely anchored complete unit.

The utilization of a wide selection of insert materials, having special properties, is just one of the many advantages of ZINC Alloy Die Castings. For further information we suggest that you consult a commercial die caster—or write to

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The Research was done, the Alloys were developed, and most Die Castings are specified wi

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Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Metallic Shielded Arc Electrode Coatings

The principal feature of the electrodes used in shielded arc welding is their heavy coating or flux covering, which acts to: (1) Form a protruding flux sheath at the electrode tip, mechanically shielding and exerting a directional control upon the arc. This is due to a lag in the consumption of the coating over that of the core metal. (2) Produce an inert or reducing atmosphere, enveloping the arc and weld metal. This results from the volatilization, dissociation and combustion of various coating constituents. (3) Provide a protective slag covering over the weld surface, obtained by the melting and reaction of the less volatile mineral ingredients of the coating.

As indicated in the abstract, (page MA 424 L 4), the ingredients used in compounding electrode coatings, of which the shielded arc type form the most important group, are exceedingly numerous and varied. The characteristics of any coated electrode are almost entirely dependent upon the combination of materials employed in the coating.—E. V. D.

Annealing and Radiant Tube Heating Have the Stage

Of the last batch of abstracts received, a number of them deal with annealing. James E. Dare (page MA 412 L 5) tells about the application of the luminous flame; Ralph M. Drews (page MA 416 R 7) controls the microstructures in high-carbon and alloy steel bolts by annealing in a bell-type furnace heated by radiant tubes: J. L. Whitten (page MA 414 R 5) features annealing strip in coils in a bell-type furnace using radiant tubes; and W. F. Ross (page MA 416 R 4) describes continuous strand annealing of cold-rolled strip in an electrically heated furnace.—O. E. H.

Cracking Tubes

Jamison (page MA 449 R 2) says that modern 18:8 cracking tubes in oil refineries are never corroded, and do not fail by sudden rupture. Some of the early tubes did so fail when they were first tried and gave 18:8 a black eye.—H. W. G.

Protective Coating for Al-rivets for Stainless

The English have been partial to lanoline coatings for protection of Al on aircraft. An improved one, in which the lanolin is hardened by resin, is mentioned by Sidery and Willstrop (page MA 449 L 5). They advocate what one might call a high Ni brass, 45 Ni, 30 Cu, 23 Zn (even though these percentages don't add up to 100, this is the composition given in the original article) for rivets for joining stainless steel.—H. W. G.

Intellectual Curiosity

Pearson (page MA 450 L 1) cites satisfying the intellectual curiosity of pipe-line technologists, as one virtue of soil survey methods, among other more utilitarian virtues.—H. W. G.

Static Electricity

Skinner (page MA 450 L 8) advances the hypothesis that static electricity can be present on shipboard and that this may have something to do with corrosion of ship plates. Evidently one needs to be careful about stroking the ship's cat.—H. W. G.

Quantity Production

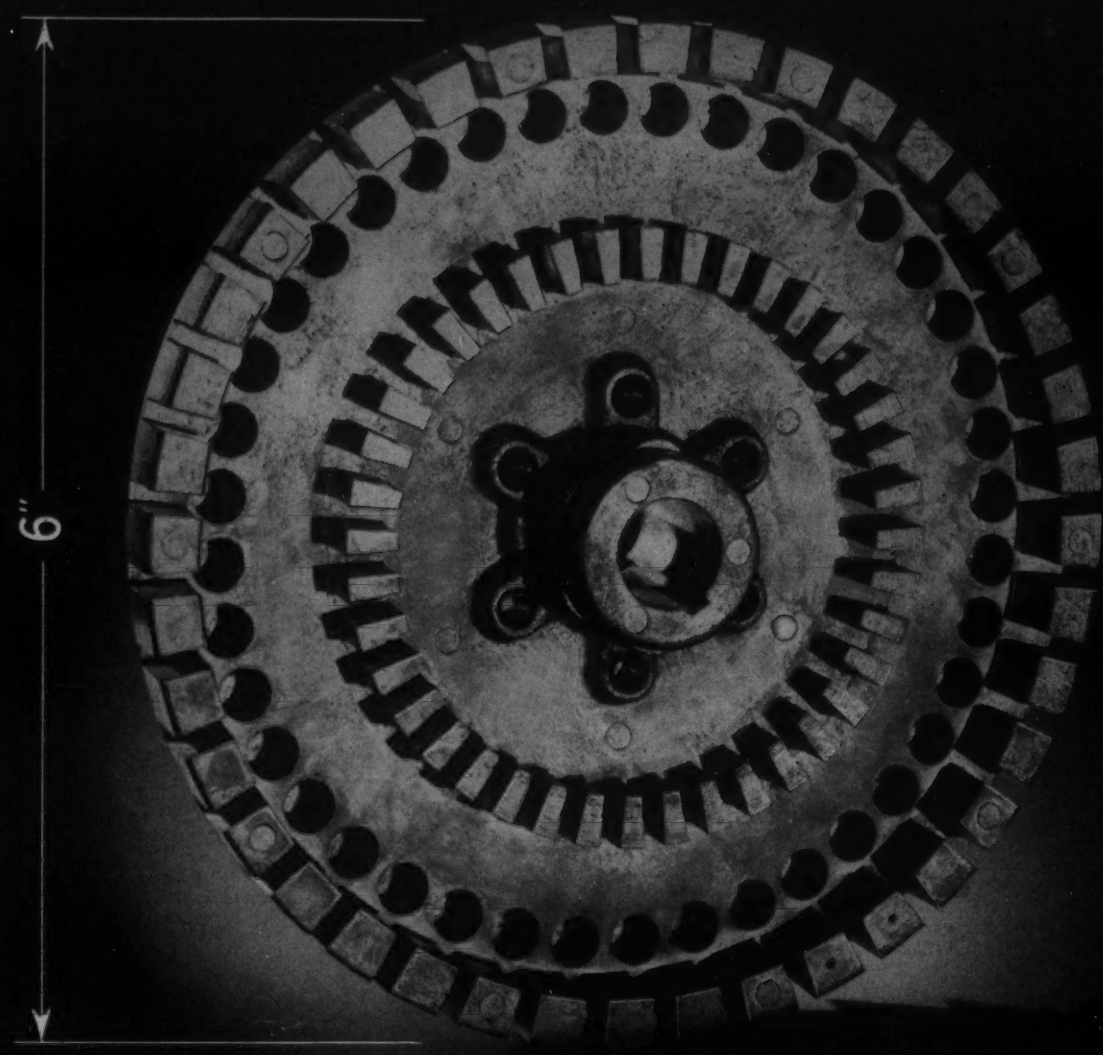
Kostron (page MA 433 R 1) describes a method for studying age hardening in which an apparatus automatically forces a Brinell ball into the specimen at predetermined intervals, leaving impressions that the investigator may measure at his leisure.—H. W. G.

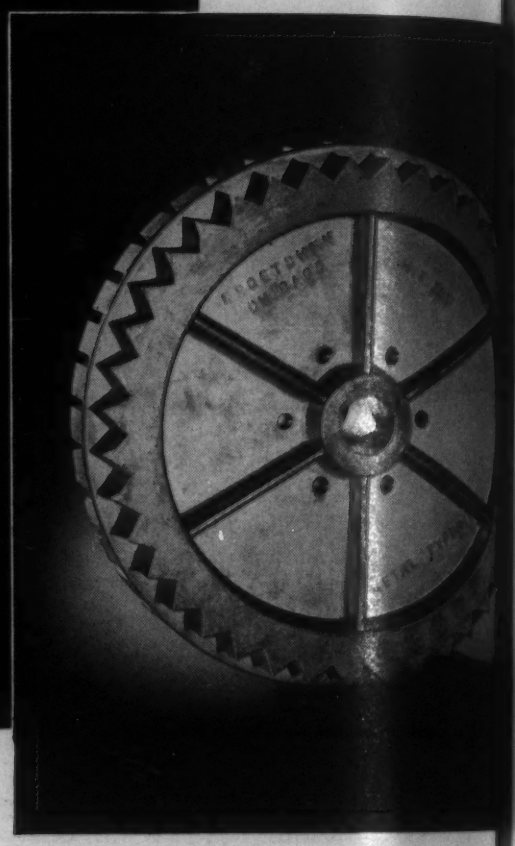
Electric-Furnace Brazing

The electric-furnace brazing process consists of uniting assemblies with brazing metal in an electric furnace containing a reducing atmosphere. The brazing metal is usually in the form of a Cu-wire, applied near the joints to be brazed. In the furnace, the metals are freed from oxides and thus prepared for wetting by the molten brazing metal.

Like other well-testablished methods of fabricating or forming metal assemblies or parts, electric-furnace brazing has a definite field in which it is supreme. This applies particularly to work where the volume of production is sufficient to justify the investment in equipment involved. In such cases, marked improvement in quality and reduction in cost of the product have been obtained. There have been many instances where electric-furnace brazing has made possible the development of a new product, which would have been difficult or impossible to make in any other way (page MA 422 R 4).—E. V. D.

ZINC ALLOY DIE CASTINGS





$11.30 SAVED

—By Die Casting This Part

When a well-known coin stamping machine was redesigned recently, the above part—the heart of the machine—was changed to a ZINC Alloy Die Casting. The saving in piece cost over the former "machined" part was $11.30. Consider *all* of the following features of this part as a die casting.

1. ECONOMY—There is no machining required on this casting other than the removal of the gate and tapping of the cored holes. The part illustrated here has received no further machine work. Here is rare complexity of design cast *in one piece.*

2. ACCURACY—The mechanism of the coin stamping machine is such that exceptionally close tolerances are demanded of this part. As a ZINC Alloy Die Casting, dimensions as close as .001" are held—and these dimensions will be the same in the first and last casting of a long production run.

3. STRENGTH—The strength of this casting is superior to that of the former part, yet there is a decided saving in weight. The smaller, rear view photograph shows the elimination of metal by the use of strengthening ribs.

This is not an unusual instance of die casting economy—hundreds of other manufacturers can cite similar savings in their products through the use of die cast parts. Consult any commercial die caster about ZINC Alloy Die Castings—or write to this Company.

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Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

All the Abstracts

This highlight is dedicated, for variety, not to an individual abstract but to the whole Abstracts department as it appears this month. We're pardonably proud of it. First, because it represents the practical culmination of efforts to improve the "timeliness" of the service—readers should note the very large proportion of abstracts of articles published in June and July, corresponding to the minimum time-lag that can be achieved in a well-edited abstracts service. And second, because this issue initiates the publication of "composite digests"—several abstracts on the same general topic combined under one head for purposes of correlation (e.g. page MA 558 L 8). If readers approve, we'll continue to run some of these every month, so let's have your reaction.—The EDITORS.

Gas-Heated Cupola

German experiments in burning gas instead of coke to melt the charge are reported (page MA 525 L 9) "very encouraging," justifying further investigation. Construction of such equipment is described.—E. F. C.

Electric Cast Iron

Three methods of making cast iron in electric furnaces are reported to be successful and spreading in use in Germany and elsewhere (page MA 528 R 3). The three methods are: (1) Combination of blast furnace and electric; (2) cupola and electric; and (3) steel and scrap iron in electric furnace with product called "synthetic."—E. F. C.

Resistance Wire

A "composite digest" on wires for electrical applications (page MA 554 L 7) contains lots of dope on resistors, a subject on which useful published information is scarce. Data of interest to both makers and users are especially replete in the paper by Sanford and Harder, and its discussion.—F. P. P.

What is an Alloy Steel?

Portevin (page MA 556 R 4) offers his contribution to the search for a definition of an "alloy steel." It's unlikely that his proposal will be widely accepted, for his "floor under alloy contents" is higher for Cr, Cu, Si or Mo than their actual content in many present-day low alloy, high strength steels.—F. P. P.

[This proposal, if compared with the minimum limits of the American Iron and Steel Institute on page 38 of the Annual Statistical Report for 1938, is strikingly different.—E. F. C.]

Flame Hardening

Sprocket teeth cast from SAE 3135 (Cr-Ni) steel are reported (page MA 534 R 9) flame-hardened satisfactorily. Brinell hardness was held between 500 and 550 on a production basis. The sprockets thus treated run about 5 times longer than untreated sprockets.—E. F. C.

Deep Drawing Tests

Engineers are still seeking methods of evaluating deep-drawability of sheet metal that reasonably simulate operating conditions. Jevons (page MA 548 R 6), most articulate of British writers on this subject, publishes an excellent comprehensive review of the present situation.—F. P. P.

Fatigue of Crankshafts

German attention to (among other things) fatigue problems in automobile crankshafts seems to be intense. Bandow (page MA 550 L 2) stresses the importance of determining fatigue properties under actual operating surface and contour conditions. Cornelius (page MA 550 R 1) agrees that fatigue strength depends on shape more than material, and states that special design may be more effective than application of alloy steels.—F. P. P.

Electric Salt Bath Furnace

In a "new type" of salt bath furnace in Germany, electrodes are arranged on one side only so that current does not flow through the part of the bath containing the steel to be heated. It is said to be suited to case-hardening, Cr-Mo steel especially (page MA 536 L 3).—E. F. C.

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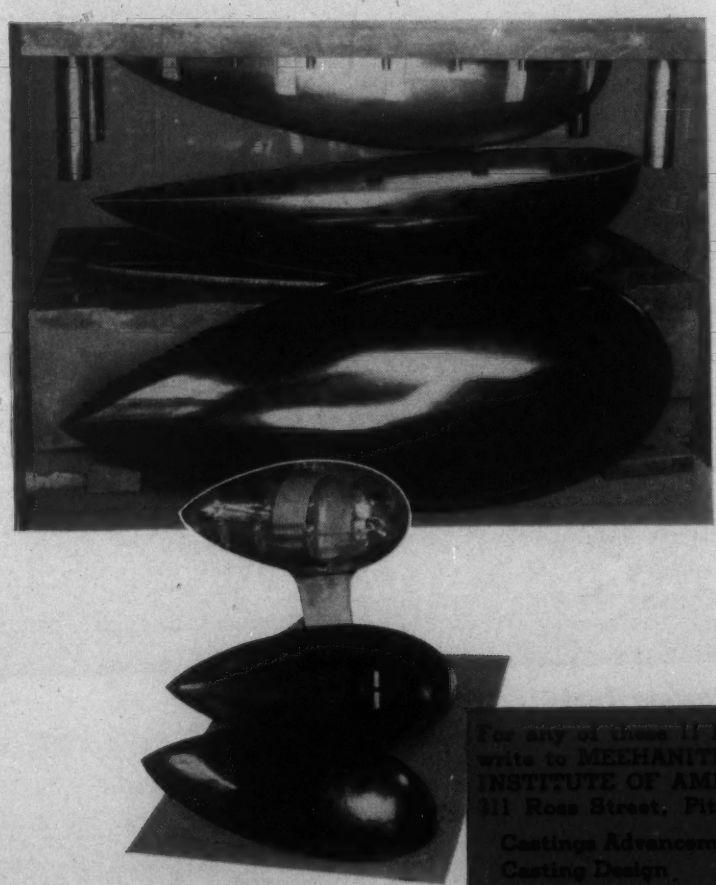

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Meehanite Metal Corporation	Pittsburgh, Pa.
Australian Meehanite Metal Co., Ltd.	Waterloo, N. S. W.

Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Open-Hearth for Malleable Iron

Under certain conditions, the open-hearth furnace has advantages in melting malleable cast iron (page MA 582 R 4). It precludes, however, fully mechanized continuous molding, because the supply of metal is intermittent. But such a supply provides a large bulk of uniform analysis with close control of composition.—E. F. C.

Seeing Stresses

Increasing applications of photoelastic stress analysis are emphasized by the number of recent articles on the method and applications of this newest of engineering tools (page MA 611 R 3).—F. P. P.

New Cupola Melting Process

The Germans have developed (page MA 582 L 5) a process for melting the cupola charge by a utilization of the heat of the fuel by radiation rather than by convection, as in the blast furnace. Instead of the heat being transmitted in the counterflow manner of burden and gas, the heat is radiated from a coke layer, heated to a white heat, on top of the burden.—E. F. C.

Aluminum Cable Sheathing

Czempiel and Haase (page MA 620 R 4), urging wider use of aluminum for cable sheathing, offer physical property comparisons between lead, antimonial lead and 2 grades of aluminum. The abstractor suspects wishful thinking, but, nevertheless, aluminum does have certain very definite advantages for this application that merit consideration.—F. P. P.

Cutting Tools

Many users of cutting tools are confronted with the problem as to which tool to use on certain materials. A "composite abstract" (page MA 583 R 9), covering three articles, gives excellent advice, based on experience, on a broad range of materials to be cut and the cutting tools.—E. F. C.

Metals in the Refinery

Several recent articles on various metallurgical problems in oil refineries have recently appeared, and are abstracted together in a "composite digest" in this issue (page MA 617 L 5). Alloy steels, stainless, stainless-clad and several non-ferrous alloys are appraised for a variety of jobs, much of the information coming from refinery operators rather than alloy manufacturers.—F. P. P.

Centrifugal Casting of Non-Ferrous Metals

By lining the cast iron mold of a centrifugal casting machine with copper sheets, 1 to 3 mm. thick, the Germans (page MA 580 R 10) have found it possible to successfully cast all the non-ferrous alloys now used, such as bronze, red brass, Monel metal, etc., free from the porosity obtained when the metal came in contact with an iron or steel mold.—E. F. C.

Metal Spray Performance

The successful experience of a large oil refinery in reducing corrosion and erosion by applying sprayed metal coatings is reported by Jones and Dewey (page MA 607 R 2). Lots of good practical information on technique and conditions is included.—F. P. P.

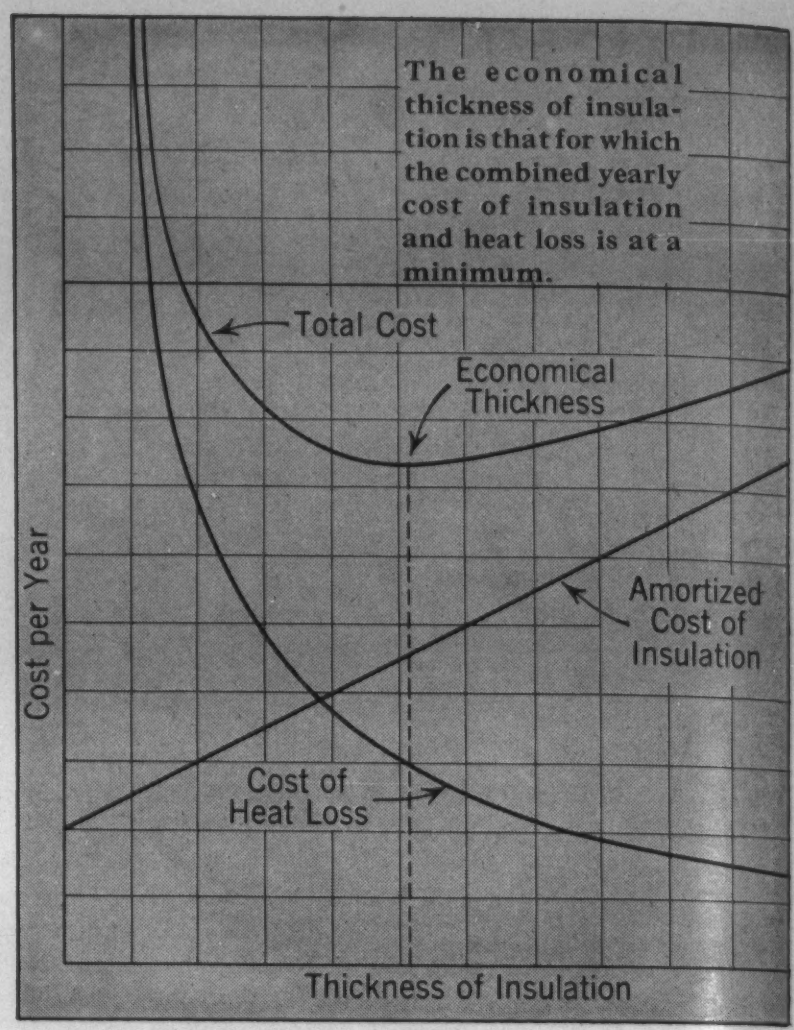
Age-Hardening of Al Alloys

A "composite abstract" (page MA 594 R 4) on the age-hardening of aluminum alloys gives valuable data on many phases of this interesting subject. Articles from all over the world recently have discussed many interrelated factors. This type of abstract presents some of the principal points as discussed by several authorities.—E. F. C.

New Hardness Tester

A new pyramidal-diamond indenter said to be suitable for testing the hardness of thinner or more brittle materials than can be tested with conventional indenters is described by Knoop, Peters and Emerson (page MA 614 L 9).—F. P. P.

How to SAVE THE MOST MONEY with INSULATION



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Do you want to know what metallurgical engineers are doing, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Reducing Mn Loss

Bardenheuer and Henke (page MA 648 R 1) apply the principle familiar to non-ferrous metallurgists as the Durville pouring method, in which turbulence is avoided, to the tapping of the open hearth, by tilting the ladle so as to keep the stream short. The avoidance of excessive contact with air is alleged to reduce the Mn loss greatly.—H. W. G.

Hundredths and Thousandths

Recapitulations by Guillemot (page MA 648 R 9) on Alloys and by Thews (page MA 650 R 8) on Zn base die casting alloys, while not presenting any new dope, do emphasize the fact that a few hundredths of a percent of an alloying element may exert a profound effect, sometimes good, sometimes bad.—H. W. G.

A Half Dozen Hardenability Abstracts in One

"Time Quenching," "A Test Method for the Evaluation of Aqueous Quenching Media for Steel Hardening," "Hardness Characteristics of Some Medium Carbon S.A.E. Steels," "Hardenability Variations in Alloy Steel—Some Investigations of the End-Quench Test," "Hardenability Studies on Tool Steel," and "A Hardenability Test for Shallow-Hardening Steels," abstracted in this issue (page MA 655 L 8) present a sizable symposium on this timely subject.—O. E. H.

Temperatures Determined Chemically

Obtaining surface temperatures of moderately heated materials is a difficult task but the Germans are reported to have made this easier by the development of metallic salts which change color at a specific temperature (page MA 655 L 5). Mixed with a binder, the salts are sprayed or brushed on the material.—E. F. C.

Colored Oxide Coatings on Aluminum

Coloring agents for anodic oxide coatings on aluminum are usually organic in nature. However, a new process described by Herrmann (page MA 670 L 4) is based on the use of salts of titanium, zirconium or thorium, dissolved in the electrolyte and subsequently anchored in the coating as opaque hydroxy-like compounds—F. P. P.

Spheroidizing

Hodapp and Leeder (page MA 658 R 8) report a great saving in time of a spheroidizing anneal by applying a sort of austempering procedure.—H. W. G.

Fish Eyes

Hiemke (page MA 663 L 8) thinks that stress relieving eliminates fish eyes in welds. The nomenclature doesn't seem any too good, for the bass we caught last summer took lots of time before their stresses were relieved, while the wall-eyes were more readily subdued. Size of fish eyes and the difficulty of relieving internal stress don't always go hand in hand.—H. W. G.

High-Speed of 1100 Brinell Hardness

It is not new to heat hardened and tempered high-speed steels in molten cyanide baths, but there is much new information about this process in the paper by Morrison and Gill (page MA 656 R 5)—O. E. H.

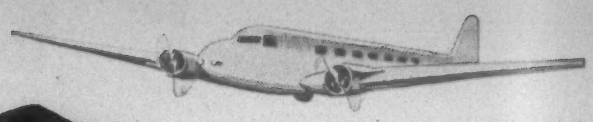
Magnesium Alloy Die Castings

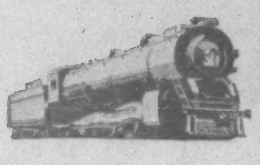
A bird's-eye-view of the widening field for magnesium alloy die castings, plus a summary of American manufacturing technique and a discussion of German automotive applications, are found in a "composite digest" (page MA 676 R 2).—F. P. P.

We Are Advertised by Our Loving Friends

Williams (page MA 655 R 7) comments on the new complex Al-V-Ti deoxidizer—or rather reagent for grain size control, "Grainal" although its producers have refrained from describing it in public as yet. If one really tried to keep a new thing truly secret, how the grapevine telegraph would hum!—H. W. G.

Progress IS PERPETUAL MOTION





Motion, fast or slow, is the breeder of problems. Whether it be the 4 feet per minute motion of a parts conveyor or the 4 mile per minute motion of an airliner—each creates problems of wear, strength, safety factors, dependability. Day by day solution of these problems is progress.

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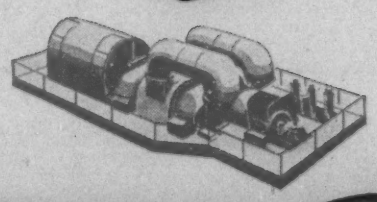

Adaptability of Meehanite to small castings is emphasized by the speed reducer unit illustrated. Note dimensions and Meehanite parts.

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Vulcan Foundry Company	Oakland, Calif.
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Rosedale Foundry & Machine Co.	Pittsburgh, Pa.
American Laundry Machinery Co.	Rochester, N. Y.
Banner Iron Works	St. Louis, Mo.
Valley Iron Works	St. Paul, Minn.
The International Meehanite Metal Co., Ltd.	London, Eng.
Meehanite Metal Corporation	Pittsburgh, Pa.
Australian Meehanite Metal Co., Ltd.	Waterloo, N. S. W.

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Age Hardening

At least 10 papers from a recent symposium on age-hardening are abstracted (page MA 704 L 6) giving the latest information on this important subject. It is a "composite digest" and is an excellent example of the new policy of presenting in this department a comprehensive abstract of the views of various authorities on a leading topic—promptly and concisely.—E. F. C.

Furnace Brazing

Using principles analogous to those of the copper brazing process for steel, Hoglund (page MA 717R3) and Wyman (page MA 717R9) respectively describe the furnace brazing of Al and of Cu.—H.W.G.

Hard Heads in the Right Places

Production of a hard "button" in the face of a hammer, surrounded by and backed by tough material, is secured by Minarik (page MA 712R2) through local direct resistance electrical heating.—H.W.G.

Bright Nickel Plating

Hothersall and Gardam (page MA 722 L 7) examine the structure and properties of bright nickel, deposited by 3 well-known methods. Now, if some one would only do a survey on the individual merits of the 3 methods from the production and application standpoints, indicating bases for selection of one or the other by the designer or plater!—F. P. P.

Submarine Flames

Lee (page MA 723L3) points out that, instead of heating a pickling bath by injecting steam into it and thus diluting it, heating can be carried out by making a flame burn beneath the surface of the bath.—H.W.G.

Deep-Drawing Dies

Among a variety of other materials whose virtues and limitations are universally recognized, Jevons (page MA 701R5) mentions, approvingly, graphitic steel.—H.W.G.

Engineering Design with "18 and 8"

The designer depending on either the stress/strain or the stress/permanent-set relationship of "18 and 8" alone obtains only an incomplete picture of its tensile elastic properties, says McAdam (page MA 723 R 1). He recommends consideration of *both* relationships, and shows why and how.—F. P. P.

Drawing Aside the Curtain

Hazelett (page MA 701L8) now dispels much of the secrecy that enveloped the direct rolling process, and discusses the bugs that beset early attempts, and the devices adopted to lick some of them.—H.W.G.

Magnesium Alloys in Europe's Motor Vehicles

A comprehensive review by Altwicker (page MA 729 L 2) of the various forms of magnesium alloys used in European cars and trucks, and their specific applications, emphasizes the trend toward greater use of magnesium in automotive construction.—F. P. P.

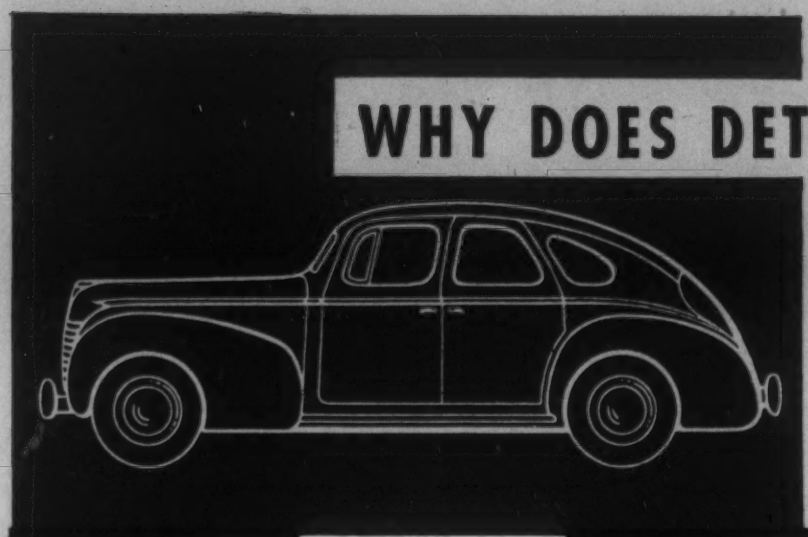
German Sponge Iron

In order to make use of some of the low-grade ores in Germany, a process is described (page MA 698 L 5) by a German author for making sponge iron from an ore containing large amounts of S, P, and SiO_2. The conventional rotating kiln is used with an Fe recovery of 90 to 96 per cent and a carbon content of 0.5 to 1.5 per cent.—E. F. C.

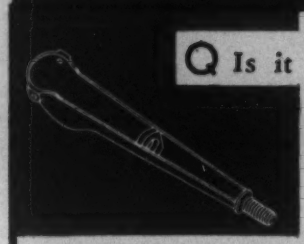
We're from Missouri

The claim is made (page MA 732R7) that a silicate treatment of Mg alloys for corrosion protection improves the mechanical properties of the alloys. That's too hard to swallow.—H.W.G.

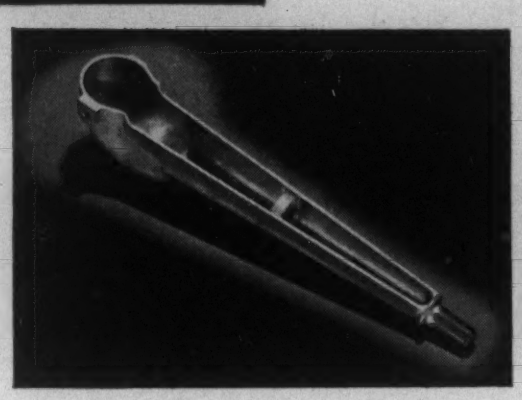
WHY DOES DETROIT PREFER DIE CASTINGS?



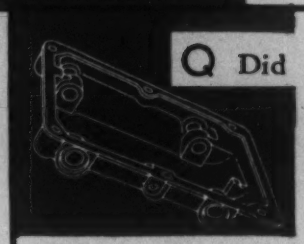
—A *Quiz*



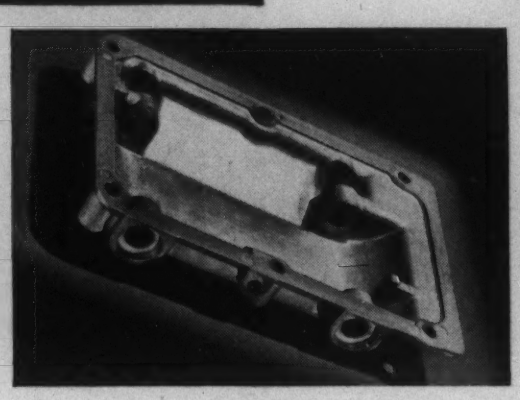
Q Is it possible to solve both appearance and mechanical problems with die castings?



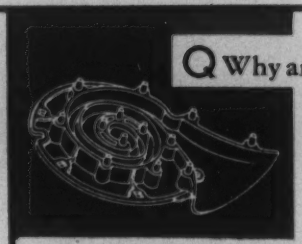
A The all-important requirement of this 1940 gear shift lever is strength. As a one-piece ZINC Alloy Die Casting this quality is easily achieved — and smooth appearance couples with low cost to make die casting the ideal method of production.



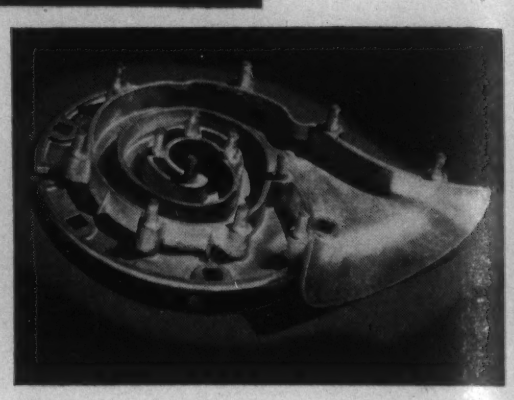
Q Did ZINC Alloy Die Castings have any influence on the design of the latest type transmission case?



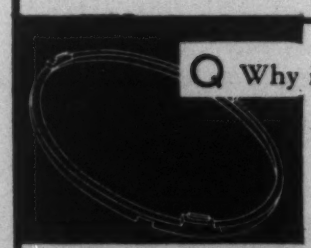
A It is highly improbable that the design of this transmission cover could have been carried out by any means other than die casting. With the usual production method, machining costs would be exorbitant.



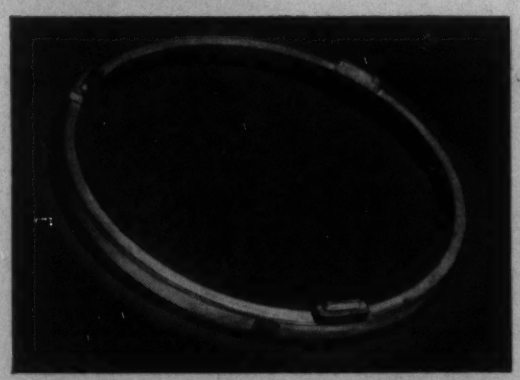
Q Why are horns back as die castings in '40?



A This is a question of arithmetic. With quality being more or less equal, the choice of material for horn construction narrows down to price. The illustrated horn part for '40 cars has a ZINC Alloy Die Cast body.



Q Why is this seal ring on new sealed beam headlights a ZINC Alloy Die Casting?



A Note the 3 integrally cast locating lugs and the knife edge on this die cast ring. The lugs facilitate assembly and the edge is spun to effect sealing. By no other method could this part have been economically produced—in one piece.

The 1940 automotive die castings reveal a flexibility of design that places this method of metal parts production in a class by itself. And this is only one industry in which ZINC Alloy Die Castings are enjoying wide application. Whether your company produces automobiles or home appliances or dime banks, you should be well versed in this modern metal and method of fabrication. Consult any commercial die caster—or write to The New Jersey Zinc Company, 160 Front Street, New York City.

ZINC ALLOY DIE CASTINGS

The Research was done, the Alloys were developed, and most Die Castings are made with

HORSE HEAD SPECIAL (99.99+% Uniform Quality) ZINC

New Equipment and Materials

The SKF Rubber Flex Pillow Block

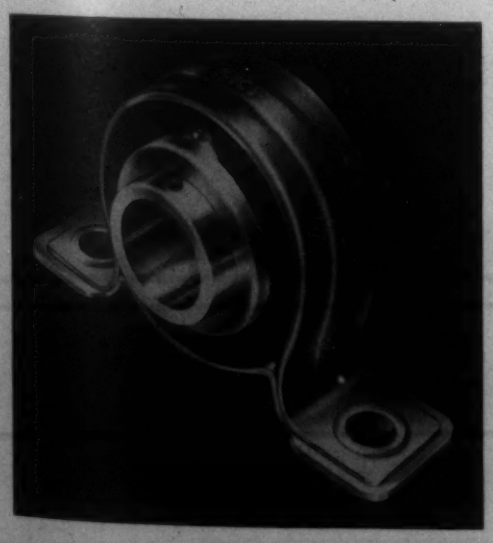
In answer to the widespread demand for a compact, sound-insulated pillow block, S K F Industries, Inc., Front St. and Erie Ave., Philadelphia, is introducing the new "Rubber-Flex Pillow Block," the result of more than 2 years' research.

This new unit comprises a self-locking bearing of the well-known S K F "Grip-lock" type. This bearing is inherently aligning, thus compensating for inaccuracies of set-up and conditions of shaft misalignment without binding or in any way impairing the load-carrying capacity of the bearing. In addition, the use of this unit brings about manufacturing economies because it requires no machining of the shaft.

The bearing is encased in a pressed steel housing equipped with felt seals to exclude dirt. The housing is provided with means for lubricating the bearing. The bearing and housing are surrounded with an elastic material having special sound-absorbing characteristics, and the material has been specially treated to make it impervious to oil and grease.

Free from the objectionable vibration usually associated with rubber mountings, this unit carries substantial loads under practically all operating conditions. Its unit construction facilitates mounting.

In short, the S K F Rubber-Flex Pillow Block constitutes a rugged, inexpensive unit which has wide application in those fields requiring anti-friction bearings with unusually quiet operating characteristics. These units are first being released in the ¾ and 1 in. shaft sizes, and are obtainable through more than 800 S K F representatives located in all parts of the United States.



Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts no more than 2 in. wide.

Copper Oxide Rectifier For Electrotyping

A new type of electrical equipment has been installed by the Shane-Beever Co., electrotypers of Baltimore, Md., consisting of a copper oxide rectifier to supply the current used in the deposition of copper and nickel electrotypes. This is the first large installation in the United States in this industry. The plant has been in use for several months and its performance, from the start, has been highly satisfactory, especially on the score of economy of operation.

The use of the rectifier, made by the Hanson-Van Winkle-Munning Co., Matawan, N. J., involved a change from the use of motor-generator sets and also a change from the use of direct current to alternating current for the power supply. One copper oxide rectifier of 3,000 amp., 6 volt capacity replaced two 1,500 ampere motor-generator sets with DC motors. The new combination has resulted in appreciable savings in power bills. The installation cost was about one-half the cost of installing a motor generator set. The maintenance cost is very low, mainly because the rectifier has no moving parts and requires practically no attendance. The Shane-Beever company has found this equipment ideal for an electrotyping shop which normally has no electricians on its staff.

The copper oxide rectifier accomplishes the rectification or conversion of alternating current into direct current by leading alternating current to a suitable step-down transformer which changes it to low voltage, high amperage alternating current. This low voltage alternating current is led to the rectifier plate assemblies, a series of copper plates which have been oxidized by a special heat treating process so that they have a uniform, dense and highly adherent coating of copper oxide. It is at the contact surface of the copper and copper oxide that rectification takes place. The direct current is led out of the rectifier by requisite leads to the equipment using it; in the instance described above, electrolytic solutions of copper and nickel for producing electrotypes.

Eveready Lifters

Illustrated in use is one of 5 models of "Eveready Lifters" which are being placed on the market by The Bastian-Blessing Co., 242 E. Ontario St., Chicago. These units provide the answer for manufacturers who are seeking a faster and safer method of handling sheet metals, sheet glass, in fact any product that has a smooth, non-porous surface. These lifters are of patented design, incorporating giant rubber vacuum cups which are provided with automatic releases that work with the flick of a finger.

All parts are sturdily constructed, fully tested and guaranteed. The vacuum cups, which can be replaced in less than 5 min. without the use of special tools, are the only parts which are subjected to wear and the manufacturer states that this replacement cost is nominal. These lifters are available in 5 models, 2 for light work, 2 for medium work and 1 for heavy lifting.

Spectrograph

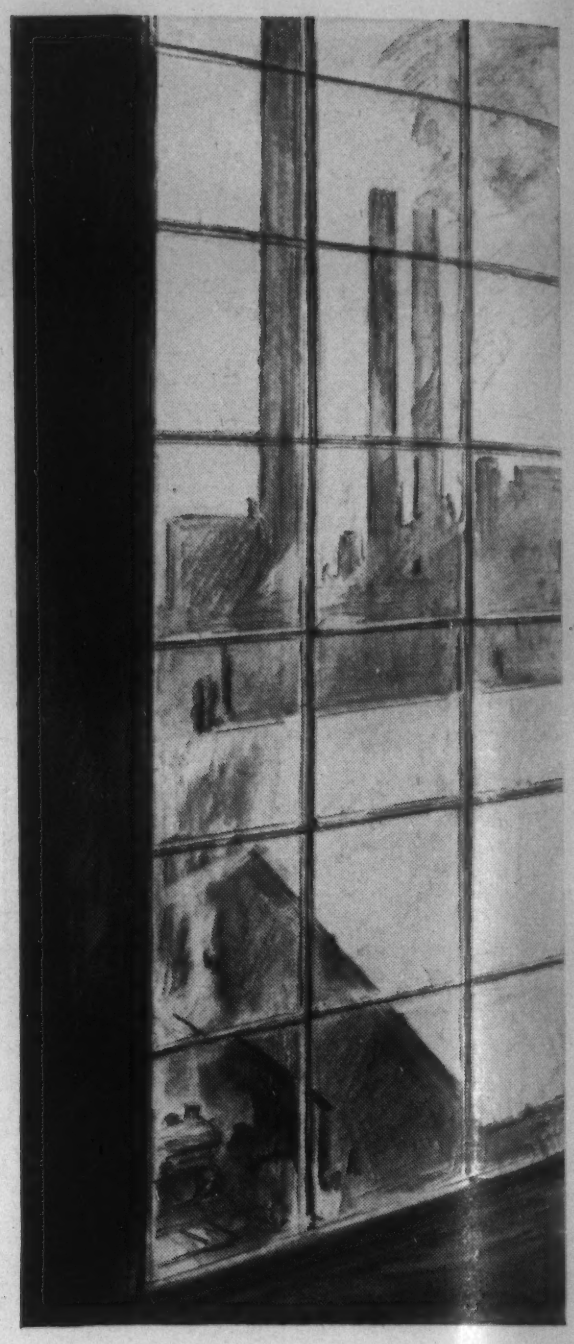
The Harry W. Dietert Co. of Detroit, announces an improvement in the applied research laboratories spectrograph. The spectograph is now furnished with an attractive and durable cover and also with an optical bench. The cover allows the spectograph to be operated in a lighted room. A film transfer case is used to remove the exposed film from the camera. This film is then taken to a dark room and developed.

The optical bench is of rigid construction, fitted with V groove to insure exact alignment of the rotating sector, lens holder, arc or spark stand, and sector photometer.

With these improvements the spectographic analysis of materials, either by the emission or absorption method, is greatly facilitated. It also allows for quick and easy film calibration with step sector.

(Continued on Page MA4)

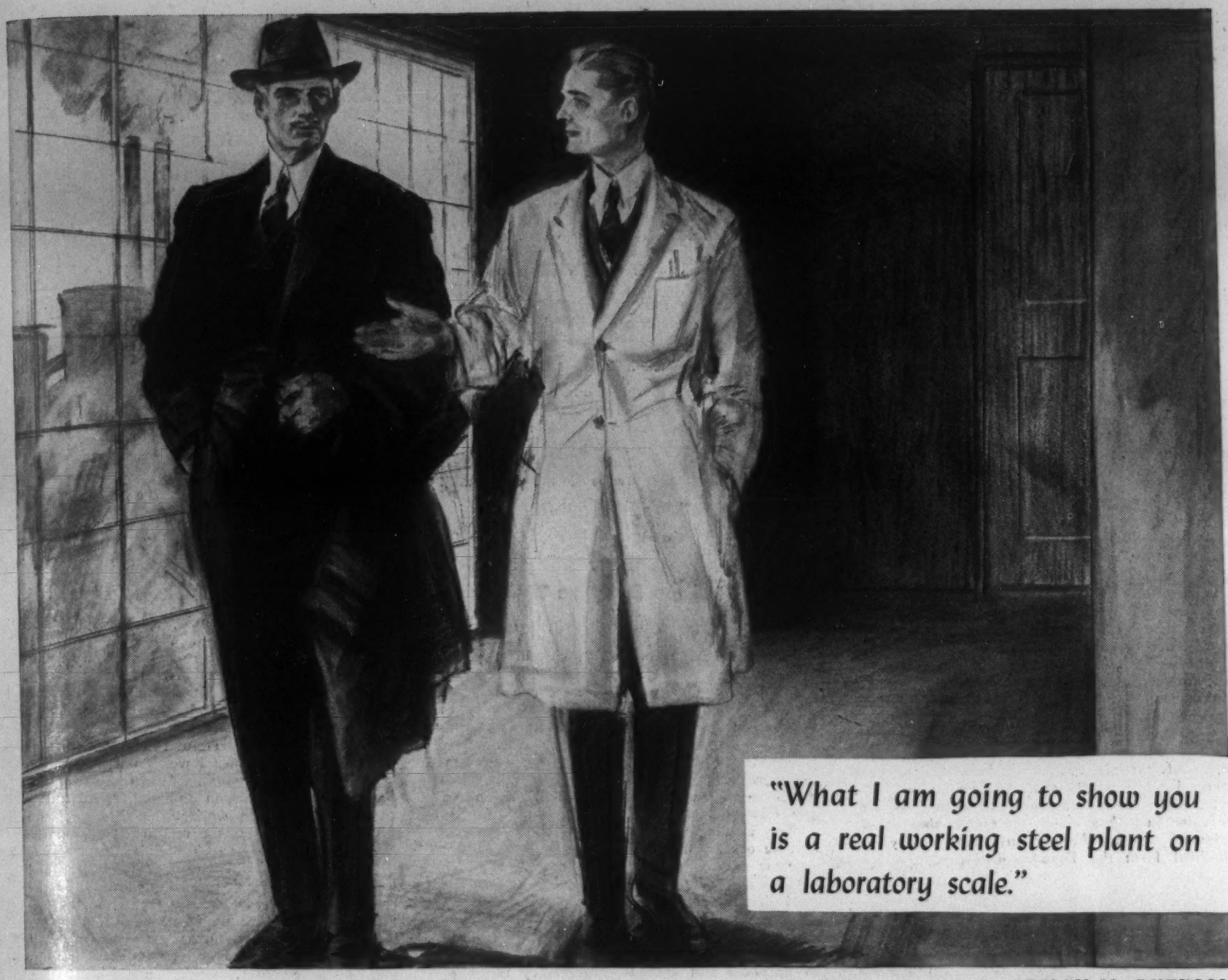
PILOTS for SHIPS NOW A PILOT FOR STEEL



JONES & LAUGHLIN GIVES ITS STEEL MAKERS A PILOT PLANT—THE FIRST AND ONLY ONE OF ITS KIND—IN WHICH TO CHART THE COURSE OF **CONTROLLED QUALITY** IN STEEL.

"Some headline writers christened it a 'pint-sized plant'—a 'baby mill'. But what I am going to show you is a real working steel plant on a laboratory scale—with a small open-hearth furnace, small ladles and ingot moulds, a little rolling mill—everything complete for steel making, all under laboratory control. Here we carry on scientific research and development to improve the quality of J&L steel, by directing the control of its manufacture.

"As a user of steel, you benefit by our accomplishments here. We've been making quality steels for a good many years. We feel we know as much about the art of making steel as anybody. But quality steel making today calls for something more than the judgment and experience of the melter and the roller. It's a matter of scientific knowledge, measurement, control. With this Pilot Plant the skill of our workmen is now supplemented by the science of the laboratory to develop new steels for you—and better ones.



From a drawing by ORISON MacPHERSON

"This laboratory adjoins our Works, making possible quick application of its findings to actual plant operations.

"It's a pilot of progress, all right, holding a steady course toward improved steel quality —controlled quality—a course J & L has pursued for many years.

"But we'd better be getting on, for it's time to tap a heat from the Pilot Plant open-hearth furnace. 'Pint size' it may be, but it's full scale in value."

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

PITTSBURGH, PENNSYLVANIA

J & L — PARTNER IN PROGRESS TO AMERICAN INDUSTRY

J&L STEEL

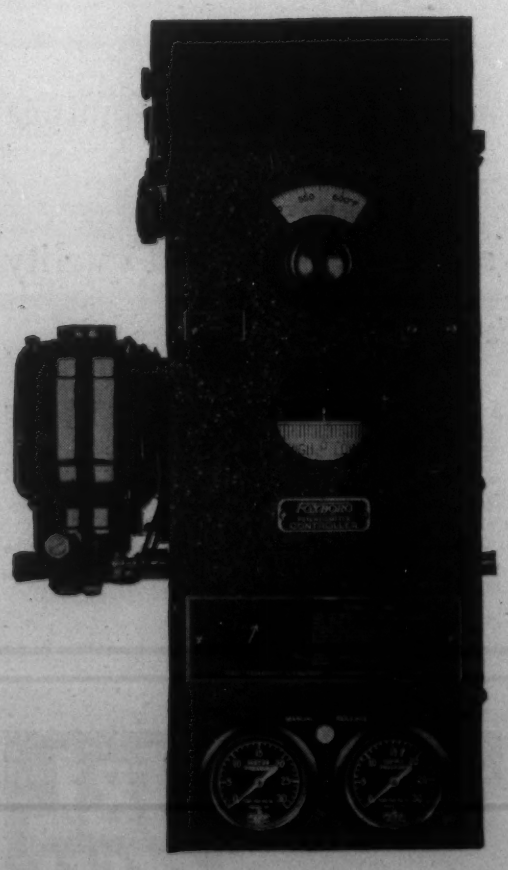
Potentiometer Control Pyrometer With Air Operated Valves

A new potentiometer control pyrometer, combining the accuracy, responsiveness and wide temperature range of electrical temperature measuring methods with the simplicity, economy and dependability of controlled valves operated by air diaphragm motors, has been announced by The Foxboro Co., Foxboro, Mass. Designed to actuate air-operated valves which are unaffected by dampness, oily vapors and corrosive atmospheres and are free from arcing and sparking electric contacts, these controllers are particularly applicable to gas, oil, steam, hot water and hot air heating, or brine, cold water or air cooling systems.

In method of measurement, electrical circuit, mechanism for detecting temperature change, construction and general appearance, these control pyrometers are identical with other models of Foxboro potentiometer controllers. In this instrument, by means of a fixed setting of the temperature dial and slide wire contact position, the mechanism for detecting temperature change acts directly in detecting galvanometer deflection, thus transmitting in control action the full sensitivity of the measuring system. The "knife edge" detecting device can pick up galvanometer deflection of 0.002-in. representing sometimes as little as 1/3 of 1 deg. F.

Direct setting of the 12-in. scale is possible to 1/5 of 1 per cent of scale range. Available ranges are from minus 300 deg. F up to 2,800 deg. F. These instruments are equipped with an automatic safety shut-off, so that if the thermocouple circuit is opened, through burnout or damage, the instrument automatically puts the valve in "safe" position.

The air control system consists of a positive, open-and-shut air control mechanism. Recommended air pressure is 17 lbs. per sq. in. To meet the majority of requirements, valves are provided in both single-seated and double-seated balanced types. Further information may be obtained from the Foxboro company.



Electric Etcher for Steel

A new, low-priced electric etcher marks iron and steel and their alloys, including hardened steels, legibly, permanently, easily and economically. It is another development of the Ideal Commutator Dresser Co., 1928 Park Ave., Sycamore, Ill. This etcher is used in the same manner as a pencil and engraves names, sizes, models, numbers or other important data on smooth surfaced parts, tools, dies, saws, plates, gears, etc. Prevents mistakes in assembly, avoids confusion in selection of tools and materials, lessens theft and loss.

The complete unit includes a handpiece and alloy point, transformer with three taps, special primary cord with tap-changing switch, secondary leads of No. 8 wire and a work plate. Weight is 12 lbs. Three etching speeds are controlled by a switch on the primary cord. Depth of the etching is governed by the speed at which the point is moved over the metal.

It is easy to use. Just plug into a suitable wall socket. Standard unit is for 110 volt, 60 cycle service. Also available for other alternating current circuits.

A 150-Ampere D-C Arc Welder

A new 150-am., direct-current, single-operator arc-welding equipment has been announced by the General Electric Co., Schenectady, N. Y., which further extends its line into the field of light-gage work. The new equipment, because of its high instantaneous recovery of voltage, provents arc pop-outs at all points in its wide welding range with any good bare, lightly coated, or heavily coated electrode. Its stability prevents excessive current surges, thus avoiding excessive spatter loss and sticking of the electrode.

Any welding current within its entire range can be quickly obtained by means of a 3-point selector switch and an easily operated dial for intermediate adjustment. Additional assurance of dependable operation is provided by a reliable means of self-excitation. Isothermic overload protection permits the equipment to carry maximum safe overloads without danger of burnouts and without unnecessary interruptions on harmless overloads.

The new d-c equipment is rated 150 amp. at 25 volts and its range of adjustments varies from 20 to 200 amp. at 25 volts.

An All-Purpose Label Adhesive

To meet the long-standing need for an adhesive capable of adhering to practically any surface, Paisley Products, Inc., 1770 Canalport Ave., Chicago, and 630 W. 51st St., New York, announces that, following exhaustive tests, its new product, "Grip-Tite Label Paste" is now being placed on the market. In an interview Earl C. Lenz of Paisley Products, Inc., said:

"This new adhesive has been perfected to make available to label users a paste which can be relied upon to hold dependably to practically any surface under almost any condition of temperature, atmosphere or climate. Countless tests have been carried on which have demonstrated the excellent adhesive power of our new Grip-Tite Label Paste on plain, lacquered and lithographed surfaces of tin, iron, copper, brass, lead, aluminum, stainless steel, bakelite, hard rubber, tile, leather, wood (either painted, unpainted or varnished), paper board, porcelain, glassware, galvanized ware, plastics and similar surfaces."

The new product is available in 1, 5, 30 and 50 gal. sizes, f.o.b. Chicago or New York City and a low price schedule makes this new paste of interest to both large and small users.

"Compar" Indicating Micrometer and Comparator

The George Scherr Co., Inc., New York, has introduced a new "Indicating Micrometer and Comparator" which includes several interesting and important improvements. Among these are the elimination of all gears and racks from the indicator mechanism. Instead, the knife-edge lever type is used, which is claimed to make the instrument more accurate, more durable and less subject to loss of precision through constant use. It eliminates the uncertainty of measuring feel since it includes a feature which makes the measuring pressure visible. There is an anvil relieving button which moves back the lower anvil for inserting and removing work. When the work is inserted and the button released, the anvil is pressed against the work by a light pressure return spring. Thus the reading is sure to be the same.

The "Compar" Indicating Micrometer and Comparator is constructed to withstand the constant wear and tear to which an instrument of this nature would be subjected in the machine shop and in quantity production. All delicate mechanism has been eliminated, resulting in a compact, sturdy instrument that measures in 1/10000 in. and is built for hard, all-around use.

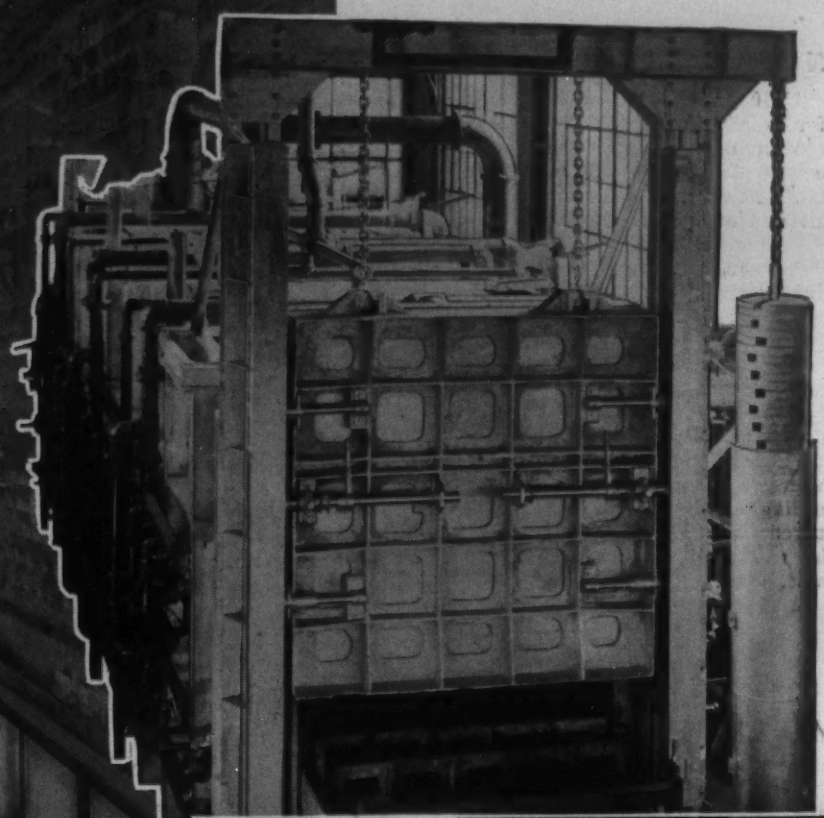
Small Radiant Tube Annealing Furnace

A small, cylindrical, bell-type annealing furnace, heated with vertical radiant tubes, and intended primarily for heat treating small tonnages per charge of coiled strip steel and coiled rod and wire, has been developed and introduced by the Lee Wilson Engineering Co., 1370 Blount St., Cleveland.

This type of furnace is used for bright annealing and spheroidizing of hot and cold reduced material for both steel and wire and also for low and high carbon steels. Copper and brass as wire or strip can also be suitably annealed in it, it is said. Liquid seal is provided for as well as the introduction of protecting gases. The furnace is claimed to have the inherent characteristics of an electric furnace plus the advantages of throttling heat control and low cost of heating per pound of material handled. There is a fan in the base for promoting circulation of gases.

The furnace is pointed to as applicable particularly where there are small charges of varying time temperature cycles. It can be used in shops where time in process must be reduced to a minimum and small orders can be run through quickly.

(Continued on Page MA6)



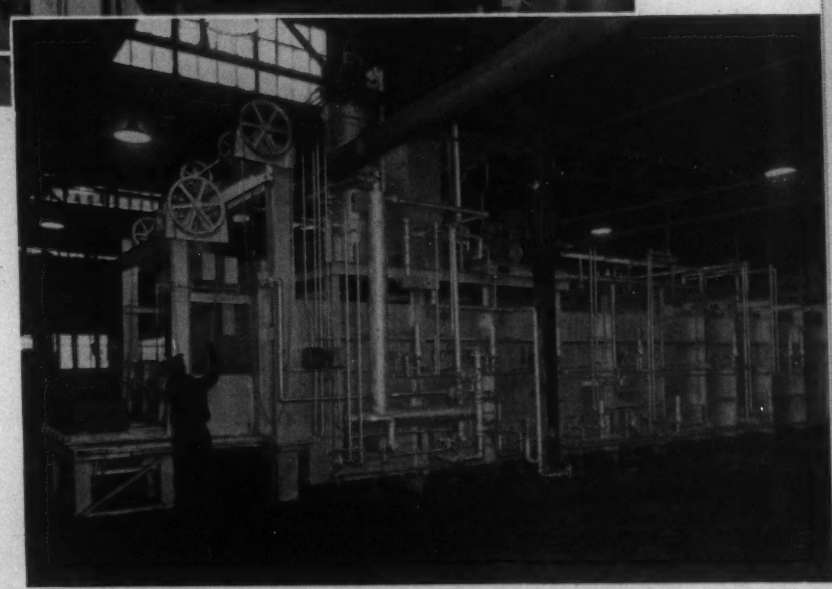
LEFT: *Interior of large car-bottom furnace installed at the Wycoff Steel Company, Chicago. 10,000 straights of Armstrong's Insulating Fire Brick assure maximum operating efficiency.*

BELOW: *Exterior view of same furnace.*

SURFACE COMBUSTION

builds high insulating efficiency into these modern furnaces

with ARMSTRONG'S BRICK



ABOVE: *Armstrong's Insulating Fire Brick assure low fuel costs and operating efficiency in this continuous radiant tube controlled atmosphere malleableizing furnace at the Jamestown Malleable Iron Corp., Jamestown, N. Y.*

SURFACE Combustion Corporation of Toledo, Ohio, is one of many leading furnace manufacturers who build maximum insulating efficiency into their equipment with Armstrong's Insulating Fire Brick.

These high quality brick meet all the requirements for efficient service. Their use permits thinner furnace walls which results in a larger hearth area. Their light weight makes them ideal for arch work. And their low heat capacity permits the furnace to come to temperature with far greater speed.

All these advantages of Armstrong's Brick assure lower fuel costs, more accurate temperature control, and greater flexibility of operation. Armstrong's Brick are available in five types for a wide range of temperatures and uses.

Armstrong will gladly furnish specifications outlining the standards required for the different physical characteristics with permissible tolerances. Write today for samples, prices, and descriptive literature. Armstrong Cork Company, Building Materials Division, 982 Concord St., Lancaster, Pennsylvania.

IMPORTANT FEATURES OF ARMSTRONG'S BRICK

1. Ample insulating value
2. High crushing strength
3. Accurate sizing
4. High spalling resistance
5. High salvage value
6. Complete line for wide temperature range
7. Ability to withstand handling in shipping and installing
8. Special shapes of all types and sizes
9. Easily cut on the job
10. Stocks available in principal cities
11. Laying cements with same physical characteristics as brick
12. Complete line of refractory facing cements for protective coatings

ABOVE: *Large car-bottom furnace for railroad car side frames and bolsters at the Pittsburgh Steel Foundry Company, Pittsburgh, Pa. Furnace is insulated for maximum efficiency and economy with Armstrong's Insulating Fire Brick.*

rmstrong's **HIGH TEMPERATURE INSULATION**

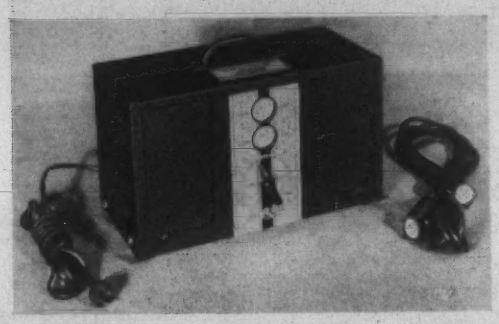
LATING FIRE BRICK • HIGH TEMPERATURE BLOCK • PLASTIC CEMENTS • DIATOMACEOUS EARTHS

New Welding Control

Uniformly high quality welds, particularly for applications where the expense and inconvenience of X-ray do not seem justified, are now made possible with the "Arc-Length Monitor," new product developed by the research division of the A. O. Smith Corp., Milwaukee.

In the vast majority of welding applications throughout industry, there has been no routine method to insure high quality work with this universally accepted production tool. Heretofore quality was at the mercy of the human element, which rested upon the training, experience and attitude of the individual welder.

X-ray has proven satisfactory within limits, but it cannot be depended upon to reveal harmful foreign inclusions in the weld metal or excessive amounts of nitrides. Various recording methods are also in use to indicate current and voltage values after completion of the weld, but there are also "after the fact" indications.



The Arc-Length Monitor is a practical development which fits into present shop practices. It helps the worker make a good weld while he is in the act of welding. Smith research proved long ago that, while control over voltage of itself is no definite assurance of a good weld, in nearly every case of poor welds there was a relation to the voltage involved. The situation, if controlled through definite indications to the welder during the process of welding removes one of the main variables in welding technique. Thus it promotes higher quality welds.

The function of the device is as follows: The welder is informed of the length of his arc by means of two tiny bulbs, mounted inside his welding helmet, one on each side of the window through which he observes the arc. Both bulbs are normally dark at the selected voltage. The one to the right glows faintly, and with increased intensity, as the voltage increases from that selected; the one to the left responds similarly as the voltage decreases from that selected. Maximum brilliance is kept well below the point of hurting the operator's eyes or interfering with his work. The instrument itself, which contains signal lights similar to those in the welder's helmet, is placed where it can be observed by the production or welding supervisor.

The Monitor will be found particularly effective where very light gage materials are used, particularly such expensive metals as stainless steel, requiring close control of the arc. It has also proven invaluable for periodically checking the ability of experienced operators and training new operators. Experiments in Smith's huge welding plant show that new operators acquire ability to hold a steady arc in about one-third the usual time. The Monitor is also useful in minimizing controversy over test results in laboratories where it is desired to duplicate working conditions for welded specimens. Incidentally, it has the psychological effect of giving the welder an inducement to exercise extra care in his work.

A Si-Al Alloy for Piston Rings

In the field of piston rings, cast iron has long held a dominating position. Ease of founding, good machinability and low metal cost have made it an economical material for the purpose. Good bearing qualities, particularly under the conditions of poor lubrication which often obtain, and the ability to retain its physical properties at quite elevated temperatures, have both been instrumental in maintaining its almost exclusive position for so many years.

Ray Day Pistons, Inc., Seattle, Wash., as pioneers in the successful manufacture of aluminum alloy pistons, felt many years ago that an outstanding improvement in piston ring performace could come in the same manner (and to a greater extent) that piston performance was improved—by the substitution of a suitable aluminum alloy for cast iron. Seven years ago it was established through exhaustive tests that none of the then existing alloys was applicable. While it was demonstrated that marked advantages in engine operation were to be derived from the light weight and high thermal conductivity of those alloys, their low elastic modulus and rather poor bearing properties made it imperative that an alloy be developed to exactly suit the needs. Such an alloy (U. S. Patent No. 2,131,076) now has been in production for about 2 yrs. Essentially, it is a hyper-eutectic silicon-aluminum alloy containing suitable age hardening constituents and very closely controlled as to impurities. Graphitic silicon is present in about the same proportion by volume as graphitic carbon in high quality grey iron, and contributes, of course, to the excellent anti-frictional qualities of the alloy.

Elastic modulus of the alloy, as heat treated for use in rings, is 15,000,000 lbs. per sq. in., determined from finished rings or from transverse tests. It is this remarkable improvement in elastic modulus over the conventional 9,000,000 to 10,500,000 lbs. for other alloys that makes it use in rings feasible. For while it is only three-fourths to two-thirds the modulus for good ring iron, the force of inertia due to mass (and which, in high speed engines is the cause of ring "paralysis") is only one-third, so that its advantage in this respect is obvious.

Thermal expansivity of the alloy is 16.1 x 10-V per deg. C., the lowest of any useful aluminum alloy produced commercially to the knowledge of the writer. Pistons have been produced of the simplest and strongest trunk type to take advantage of this low expansivity, and over a period of years, in the most gruelling types of service, these pistons have proven unquestionably superior to those cast from other alloys.

The alloy is used in two conditions—heat treated to 180 Brinell for piston ring use and to 110 Brinell for piston use. Ductility under either condition of heat treatment is not measurable.

In short, the aim has been to provide an alloy having those properties of cast iron that are considered valuable without sacrificing the thermal conductivity and low density of aluminum. Thousands of hours of successful operation in the field indicate that the company achieved such a combination of properties.

Strip Heaters

Two new types of strip heaters designed to produce fast, economical heat have been announced by the Westinghouse Electric & Mfg. Co. Made in two temperature ratings, 750° F. and 1200° F. on the sheath, these heaters are particularly applicable on crane cabs, valve house, elevators, ovens, metal water tanks, pipe lines, hydrants, hot tables, metal moulds, foundry platens—wherever ease of application and convenience are requirements.

Heaters may be obtained either with both terminals at one end or at opposite ends for installation convenience. Heating elements, with refractory insulation and sealed against moisture, are completely enclosed and bolt holes are provided at each end for quick and permanent installation.

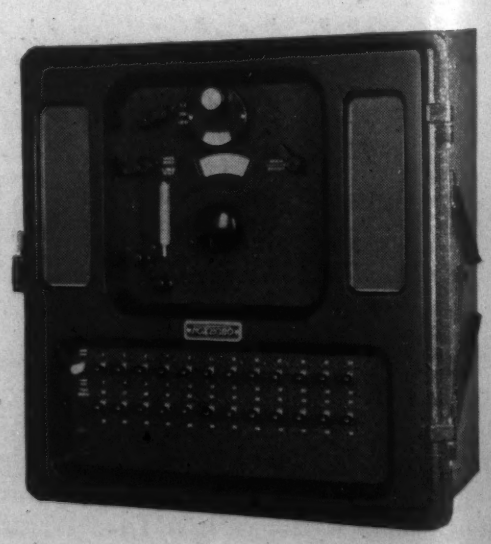
Available for operation on 115 volts, 230 volts and two styles for 250 volts, the heaters include sizes of 8, 12, 18, 24, 30½, 36 and 43 in. in length with ratings from 150 to 1250 watts.

Indicating Potentiometer

A new key-switch cabinet indicating potentiometer has been introduced by The Foxboro Co., Foxboro, Mass., to provide centralized temperature indication for numerous and scattered points in industrial plants. As many as 82 switches may be obtained on the key-switch panel, assuring complete coverage of all desired points for temperature information.

Switch identification plans are arranged for maximum convenience beside the indicating panel containing the scale and vernier dial-knob. Designed for ease of installation, the instrument case is of the universal type, suitable for surface mounting on the wall or flush mounting through the instrument board. All connections are made from the front of the board, greatly simplifying the wiring. The case, made of pressed steel, is provided with 10 knockout openings so that connections can be made at the top, bottom or sides.

In order to make balancing rapid, yet precise, the potentiometer is equipped with a vernier dial-knob. A unique vernier-type rheostat makes standardizing easy and exact. The instrument can be used with either single or double range (upper and lower) for one or two types of thermocouples, and with scales calibrated in degrees Fahrenheit, degrees Centigrade or in millivolts. High scale legibility is obtained by use of a scale 17-ins. in length. Temperature readings can be made down to 1 degree on a 1,000 deg. F. scale. Accuracy of the indicator is guaranteed to be within 1/4 of 1 per cent of the full scale.



For accurate standardization, the potentiometer circuit is so designed that when the galvanometer is used to balance the circuit against the standard cell, the galvanometer deflection is four times as great as its deflection on temperature measurement.

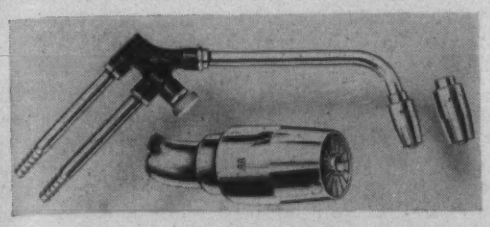
The automatic cold junction compensation coil is interchangeable with a coil of constant resistance value, which can be substituted when the instrument is checked electrically. In checking, then, this feature eliminates the need for calculation or allowances for the compensation factor. Mounted on the connection terminal strips, the automatic cold junction compensation coil, for all ranges, has the same temperature as the ends of the thermocouple extensions, thus providing accurate compensation. All switches, and the rheostat, are totally enclosed and dust-tight.

(Continued on Page MA7)

Blowpipe With Radial Grip Tip

The S. S. White No. 8 Blowpipe, manufactured by the S. S. White Dental Mfg. Co., 10 E. 40th St., New York, is a high intensity gas and air torch for general purpose soldering, brazing, etc. It is an extremely well made torch and has a number of novel features which give it a high efficiency and make it easy and comfortable to use.

It is regularly supplied with three carburetors: No. 1 for coal gas (also called manufactured or city gas); No. 2 for natural gas, propane, pyrofax, or other petroleum gases; No. 3 for mixtures of these gases. Carburetors can



be changed in a few seconds with a screw driver. Each carburetor is so constructed that any increase of the flow of air at the bench connection automatically increases the flow of gas from the main line.

Two readily interchangeable tips are available. The smaller, supplied as standard equipment, is suitable for all ordinary soldering and brazing operations. Its flame can be held to a fine needle point or increased to a strong blast. The larger tip is for use where large quantities of alloys must be rapidly melted. The unique design of the tips causes two concentric flames to be produced: A strong, cone-like inner flame, and a distinct outer flame that acts as a pilot light. No matter which gas or gases listed herein is used, and no matter what type of flame is required, the flame produced will be clear and definite.

The "pistol" grip handle enables the operator to use the blowpipe with hand and wrist in a comfortable unstrained position. By simply loosening a nut, the pipe and tip can be turned to produce a flame in any direction for heating or soldering operations where it is desirable to have the blowpipe rest on the bench, thus leaving operator's both hands free.

Automatic Welding Head

An unusual application of fractional horsepower motor drive has been recently made by Una Welding, Inc., in collaboration with the engineers of The Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, to obtain exceptionally accurate and sensitive electrode-feed control on the former company's automatic metallic arc welding machines. This control system consists of two motors instead of only one, as in other types. The larger of these motors, a separately-excited direct current machine, tends to feed the electrode rod down against the work; and the other, a constant-speed a.c. motor, to pull it upwards away from it. The two units are geared together by a differential on the feed mechanism shaft so that the electrode rod is moved up or down according to the difference between the two motor speeds. The "down" motor is connected between the electrode and the work, the "up" motor being controlled by a relay in series with the welding current circuit. By the use of a rectifier, the system may be used when the welding current is alternating instead of direct. On pressing the "start" button, the "down" motor receives full open circuit welding voltage, (cut down by means of tapped resistance to 20 to 40 volts), and it therefore feeds the rods downwards till it touches the work. The "down" motor is now practically short-circuited, and is de-energized—excessive current flow being prevented by the series rheostat used for pre-setting the arc length. The rush of welding current, however, operates the relay energizing the "up" motor. This instantly pulls the electrode rod away from the work, thus striking the arc. Both motors continue to run; the rate of feed being controlled, as before, by the difference in the motor speeds—which in turn is directly proportional to the voltage of the arc and the rate at which the rod is consumed, thus taking care automatically of any irregularities in welding conditions which may occur as the work progresses. The motors themselves are designed for low starting current, prompt response to changes in welding conditions, and to conform to close speed limits for any given voltage, whether they are starting up cold or are heated by the day's run.

"Airkool" Air-Hardening Die Steel

The Crucible Steel Co. of America, 405 Lexington Ave., New York, has introduced a new die steel to which has been given the name "Airkool." It is said to have been developed in response to requests from many industries for a new steel intermediate between the high carbon high chromium and oil hardening types in performance, at the same time approaching the non-deforming and easier machining properties of the latter.

As a result of extended research, the company developed a composition which "exactly fitted the demand." Because of the simplicity of its hardening treatment it was christened Airkool. It is believed to be of outstanding importance to die steel users, in that it combines air hardening characteristics with non-deforming properties. It is recommended for applications in which toughness is one of the principal requisites.

It is an air hardening Cr-Mo-V steel. Annealed to 1600 to 1650 deg. F. and cooled in the furnace, its Brinell is 197 to 223. Hardened in air from 1750 to 1850 deg. F. and tempered at 300 to 1000 deg. F., its hardness ranges from 63 to 58 Rockwell C.

(Continued on Page MA8)

THE LAST STEP

IN THE PRODUCTION OF

ST. JOE *Electro-Thermic* **ZINC**

The ore from the St. Joseph Lead Company's zinc mines at Edwards and Balmat, New York has passed through the smelter at Josephtown, Pa. The last step in production is now being taken, the casting of the slabs of zinc. Soon they will reach the consumer, and another transformation begins. Some will go to rolling mills and emerge as strip or sheet. Galvanizers use others to protect wire fences and sheet steel roofing against corrosion. Tons of them will appear in the countless products made of brass and nickel silver. Irrespective of the purpose for which it is to be used, one of three grades of St. Joe Electro-Thermic Zinc will meet your requirements.

ST. JOE HIGH GRADE • ST. JOE INTERMEDIATE • ST. JOE PRIME WESTERN.

ST. JOSEPH LEAD COMPANY

250 PARK AVE., NEW YORK ELdorado 5-3200

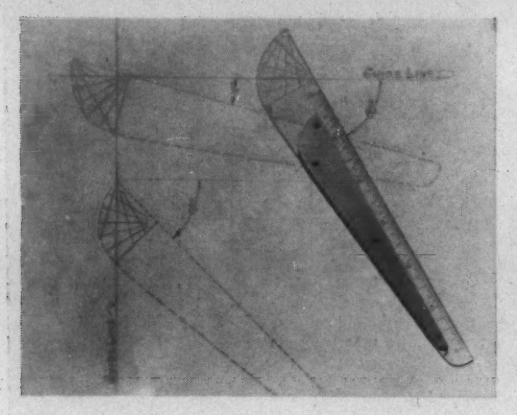
PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PA.

The U-Draft, a Pocket Drafter

A new pocket "Drafter" known as the "U-Draft Pocket Drafting Machine" has been put on the market by L. G. Wright, Inc., 5209-36 Euclid Ave., Cleveland. This new instrument combines T-square, triangles, and drafting scales into a unique combination so that the instrument literally is a pocket size drafting machine. It is 7½ in. long overall and 1¼ in. wide.

The instrument consists of a graduated scale and a protractor head on which lines are inscribed at 15-deg. angles to the horizontal scale. The instrument is made of pyroxlin specially treated drawing instrument material and all of the scales are engine divided on the pyroxlin. A metal stiffener, eyeleted to the pyroxlin, keeps the instrument flat.

In use it is possible to make an accurate drawing 6 by 6 in. on any kind of paper. With the instrument, angles 15 deg. apart may be drawn and all lines may be drawn accurately to length. It is supplied in 4 different graduations, as follows: full size 1/16 in, millimeters, full size 1/10 in, and also 1/8 in. and ¼ in. equals one foot.



The tool is ideally suited for all types of mechanical drawings, cabinet drawings, installing diagrams, mathematical solutions, graphical calculations, floor plans, lettering, layouts, quick sketches, and dimensioning on larger drawings. It is likewise an excellent premium item for engineering salesmen to distribute. List price (including instructions) is 50c providing a choice of graduations.

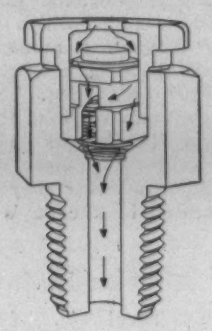
Container for Salts

The A. F. Holden Co., New Haven, Conn., offers a new 100-lb. container for "Holden Light Case" and "Holden Hard Case" that is more usable, from the customer's standpoint, inasmuch as it has a large cover that makes it easier for the operator to remove materials from the drum. Incidently because of its reduced diameter the package occupies less floor space in the heat-treating department.

The Holden company exhibited these new series of baths in operation at the National Metal Show in Detroit. The value of these products lies in their easy washing plus the fact that for the first time the carbonate in a casing bath is made of value. The company, through its research department, has developed a new reactive carbon with carbonates which acts on a percentage basis so that CO is generating not only from sodium cyanide present in the composition, but from the carbonate as well, which is a by-product of sodium cyanide oxidization.

Trends in equipment depend on the trends in the industries served. You will find the editor's interpretation of these, based on news as it happens, in "Trends" on page MA 70.

Alemite Button Head Fitting



A new, free-flow giant Alemite button head fitting, designed to speed-up the lubrication of heavy machinery, has been announced by the Stewart-Warner Corp., Chicago. Bearings requiring large amounts of lubricant—such as those on tractor track rolls—can be lubricated in less time than with older types of fittings, and with less chance of damage to grease gun equipment through overloading, the manufacturer states.

In the new fittings, the usual valve core has been replaced with one which has a flat face and seat, and which, when open, offers practically no impediment to the free flow of lubricant. By expanding the diameter of the valve retaining-spring, lubricant flows unobstructed through the center of the spring and not through its compressed coils. The improved valve opens easily under slight pressure, and provides an effective and tight seal against the loss of lubricant when the pressure is removed.

The bodies of the new fittings are hardened to withstand rough treatment. Their smooth tops, which eliminate the cutting or wearing of the coupling sealing washer, are a new feature.

Ordinarily it is impractical to bring heavy machinery to a power-driven compressor, and many operators rely on hand-operated portable compressors to lubricate their equipment. Although many of the portable compressors are capable of producing high pressures, forcing lubricant through partially-obstructed fittings requires time, labor and a strain on equipment which can be eliminated by the new fitting, Stewart-Warner engineers claim.

Test On Hardened Lathe Bed

One of the most interesting and unusual experiments ever made in the lathe field is entering its seventh consecutive month in the test laboratories of the Monarch Machine Tool Co., Sidney, Ohio. More than 7 months ago, when Monarch announced its flame hardened and ground lathe bed, a wear test was started between a hardened and unhardened lathe bed.

Two similar beds were selected for this test, one of them being unhardened, while the other was flame hardened and ground. Each carriage carried a 500-lb weight. A crank arrangement, operated by an electric motor, moved each carriage 1 ft. of travel on each lathe bed. At the time this test was announced, over 1,250,000 passes had been made over each bed.

This break-down test has been going on without interruption, except during calibration and measurement inspections, for over seven months. As of November 2, the two carriages had made more than 6,000,000 passes over each bed. The unhardened bed has worn more than 0.002 in. over the entire area. It shows a deep score on the inside of the front flat and on the carriage "V" as well. The flame hardened and ground bed has no measurable wear and not a single scratch.

Ferromagnetic Cores for High Frequency Transmitters

A new ferromagnetic core, developed primarily to enable transmitter design engineers to reduce the size and increase the efficiency of tank circuits and loading coils, and provide for continuous and smoth adjustment of circuit tuning over wide frequency ranges, is announced by P. R. Mallory & Co., Inc., Indianapolis, Ind.

The use of finely divided iron cores in radio receiver design is firmly established and of unquestioned value. Heretofore, the use of cores in transmitting has been impractical due to problems of voltage breakdown and heating of the material in the intense field. The new Mallory core combines the inventive genius of W. J. Polydoroff—a pioneer in the development of iron cores for communication use—and the science of powdered metallurgy as perfected by Mallory engineers. This core successfully overcomes previous objections to the use of ferromagnetic materials in R. F. power circuits.

General applications include (1) antenna loading inductances; (2) antenna chokes; (3) tank circuits in final amplifier stages; (4) aircraft, mobile and portable transmitters, and (5) modulation transformers and chokes. Special shapes of Mallory cores may be had to replace other types of laminated cores in audio modulation circuits. The use of these finely-divided cores results in extended frequency response and higher circuit efficiency.

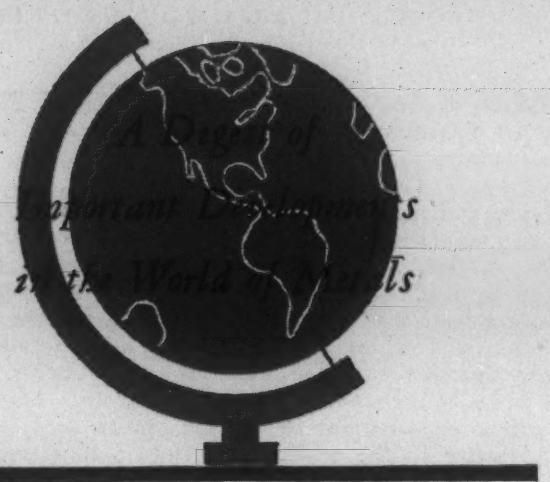
The cores are available in cylindrical form with diameters varying from 1 5/16 in. to 8 3/16 in. Length can be made as desired, but for optimum and economical considerations the recommended length should be twice the diameter. All Mallory cores are made of highly compressed ferromagnetic particles of extremely small size, with a density of approximately 4.5. Insulation resistance is approximately 1000 ohm-cm. Two core materials for different frequency ranges and applications are available in all diameters, and in 2 grades, Grade A and B.

Chrome Leather Handguard

A reversible chrome leather handguard, which fits either hand, has recently been placed on the market by the Industrial Gloves Co., 702 Garfield Blvd., Danville, Ill. This new handguard, designated as No. 12237, provides efficient protection in handling operations including metal sheets, metal shapes, stampings, bars, angle irons, etc., and gives double service because it may be worn on either hand.

In order to assure maximum protection, steel ribbons have been placed diagonally on wearing surfaces to give greatest protective service against sharp, cutting edges of objects handled. The guard is 7 in. long and may be worn in connection with cotton glove or over bare hand as preferred. It may be had in 6 and 7½ in. lengths and is available in plain leather, and without steel ribbons, also, in wool felt, cotton webbing and rubber.

Current Metallurgical Abstracts



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JANUARY, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

1·ORE CONCENTRATION

Crushing, Grinding, Plant Handling, Gravity Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

JOHN ATTWOOD, SECTION EDITOR

Determination of Adhesion Energy and the Problem of a Characteristic Value for Collectors. Contribution to Flotation (Adhäsionsenergiebestimmungen und eine Betrachtung über die Möglichkeit der Bildung einer Sammlerkennziffer. Ein Beitrag zur Schaumschwimmaufbereitung) S. VALENTINER. *Kolloid-Z.*, Vol. 83, Apr. 1938, pp. 1-9. Theoretical and experimental research. The following 2 factors must be considered in evaluating the suitability of a collector for flotation: (1) Adsorption of the collector molecules by the components of the mixture, (2) interaction between the molecules of the collector and frother. Contact angle determination or, better, adhesion energy determinations yield information on the adsorption capacity of the components. When interpreting the experimental data, the solubility conditions must be considered. Adhesion determinations were made for a number of systems. The surface tension of several solutions, their boundary tension against pure benzol and water, and the contact angles of some solutions against galena were determined. EF (1)

Collection of Coarse Gold and Mineral—Use of Strakes, Jigs, Hydraulic Traps, Unit Flotation Cell and Scavenging Cells. *Chem. Eng. Mining Rev.*, Vol. 30, Sept. 10, 1938, pp. 479-480. Practical. Jigs cannot operate to advantage on all types of ore. When the Au or mineral, or both, are comparatively coarse, they may be used. Disadvantages of the hydraulic trap are the dilution resulting from the added water and the fact that a large quantity of Fe from the grinding operation may be collected. A unit flotation cell will replace a jig. The discharge from the ball mill is fed directly to the flotation unit and a froth concentrate removed. Scavenging flotation cells are used to treat the residues from the roasting-cyanidation plant of Loloma (Fiji) Gold Mines, N. L. Tavua, Fiji. These cells are expected to reduce tailing losses and to take care of plant irregularity, such as imperfect roasting or agitation. WHB (1)

Economy in Dump Treatment. JOHN C. RUSSELL. *Eng. Mining J.*, Vol. 139, Sept. 1938, pp. 52-53. The dump of the Santiago Metals Co. on Mt. McClellan, Colorado, furnished a product of such grade that only the fines could be economically handled. The principal difficulty in milling was the tendency of the coarser material in the primary table tails to build up in the conditioner. This was overcome by installing a wet vibrating screen at this point, the separation being made at 28 mesh and the oversize being by-passed around the flotation circuit to the pilot table. The amount of material by-passed is less than 10%. Flotation reagents employed on this oxidized dump ore are sodium ethyl xanthate, copper sulphate, pine oil and Barrett's No. 2. The flowsheet is shown. WHB (1)

Effect of Sea-water on the Flotation of Sulphide Minerals. GAICHI YAMADA. *Suiyokwai-Shi*, Vol. 9, Aug. 1938, pp. 589-598. In Japanese. Original research. The floatability of pyrite, galena, chalcopyrite, black jack, ruby Zn, marmatite, enargite, arsenopyrite, stibnite and molybdenite were examined in 3.5% NaCl solutions of various H-ion concentration by using camphor white oil, K-ethyl xanthate and kerosene. The floatability of these sulphide minerals in sea-water is similar to that in distilled water. The "natural froth" of flotation in sea-water, i.e. the froth without any addition of frothing agent, generally has no collecting power, but easily floatable sulphide minerals, *e.g.* stibnite and molybdenite, are partially collected in the natural froth. Maximum floatability of galena in sea-water lies in the pH range 5.1-10.6; that in distilled water in the wider range 1-11. Floatability of enargite is notably depressed in sea-water. HN (1)

Pullman (Wash.) Unit, Electrometallurgical Section. H. A. DOERNER. *U. S. Bur. Mines Rept. of Investigations* No. 3406, July 1938, pp. 25-28. The program of this laboratory and progress thereon are described. Beneficiation of magnesite ores by 3 processes has been reported: (1) Cyclic leaching, (2) selective calcination and screening and (3) flotation. The magnesite concentrate is calcined and $MgCl_2$ formed by reaction with C and Cl. $CaCl_2$ impurity can be removed by distillation or Mg can be distilled from the Ca-Mg alloy obtained by electrolysis of the $CaCl_2$-$MgCl_2$ mixture. Experiments on direct reduction of MgO by C are reported. AHE (1)

Producing Zinc at Trail—Roasting, Leaching, Electrolysis, Melting, Cadmium Recovery. JOHN B. HUTTL (Staff) *Eng. Mining J.*, Vol. 139, Sept. 1938, pp. 42-45. Treatment of Sullivan and custom Zn concentrates involves suspension roasting, leaching, purification, electrolysis, melting and Cd recovery. The outstanding development at the Zn smelter is the perfection and adoption of the burning concentrate roasting process. The roasting of the Zn concentrates in suspension is conducted in converted Wedge roasters. Flowsheets are shown for the main leaching plant, the oxide leaching plant, and the Cd recovery plant. WHB (1)

Former Importance and Future Possibilities of the Lead and Zinc Deposits on the Left Bank of the Ruhr in the Mining Distric of Werden (Frühere Bedeutung und Zukunftsaussichten der Blei- und Zinkvorkommen auf der linken Ruhrseite im Bergrevier Werden) B. KAMPERS. *Glückauf*, Vol. 74, Aug. 27, 1938, pp. 733-738. The geological conditions are discussed, and the present and future chances that may justify reopening and reoperating mines that had been closed about 50 years ago because of falling prices are described in detail. A profitable operation is considered very likely. Ha (1)

Have you read "TRENDS"...

See page MA 70 for Editor Cone's concise discussion of recent developments that point the trend in metallurgical engineering.

2·REDUCTION

Blast Furnace Practice, Smelting and Electro-refining.

A. H. EMERY, SECTION EDITOR

2a. Ferrous

The Hydraulic Properties of Blast-furnace Slag (Die hydraulischen Eigenschaften der Hochofenschlacke) G. MUSSGNUG. *Mitt. Forsch. Anstalten Gutehoffnungshütte-Konzern, Oberhausen,* Vol. 6, July 1938, pp. 153-168; Aug. 1938, pp. 169-180. Original research. An exhaustive investigation was made into the properties and reactivity of blast-furnace slags produced in the manufacture of various types of pig Fe and the conditions under which it sets. The hardening of the rapidly-cooled, highly basic slag depends more on the temp. at which melted than on the chemical composition, the hotter the slag was melted, the better it hardens. Some properties are strongly influenced by the SiO_2/Al_2O_3 ratio; the hydraulic strength increases with increasing SiO_2 content, while the strength in air does not increase and shrinking decreases. Increasing Al_2O_3 content, although greatly improving hardening in water and air, also strongly increases shrinking. A rapid testing method is described that permits determination of the reactivity of high-basic slags within 12 hr., with good practical success. Tables of composition and equilibrium diagrams of slags are given. 23 references. Ha (2a)

The Sintering Process and Some Recent Developments. JOHN E. GREENAWALT. *Metals Tech.,* Vol. 5, Sept. 1938, T.P. No. 963, 22 pp. Practical. Modern practice of sintering, with especial reference to Fe ores, is reviewed. The best method is to place the material (mixed with fuel if S is low) on a grate, ignite from the top, blow air through the mass from the top, and maintain a vacuum under the grates. The increased efficiencies resulting from the vacuum are shown. In sintering Fe ore it is undesirable to form ferrous silicates. With the sinter now available better furnace operation results from the use of sinter than with the use of all lump ore. It is predicted that lime will be added to the fine ore to produce a self-fluxing sinter. JLG (2a)

Noteworthy Developments in a Blast Furnace Lining (Bemerkenswerte Neuerungen bei einer Hochofenzustellung) J. STOECKER & A. REIN. *Stahl u. Eisen,* Vol. 58, Sept. 8, 1938, pp. 965-970. Practical. Several innovations in a new blast furnace that gave a saving in material, more uniform operation and greater output are discussed. New cooling boxes were developed. These were made of Fe, smaller than usual, more numerous and spaced closer together. The boxes reinforced the lining, which could be built thinner, and maintained its contour well. The outer casing of the shaft was of welded steel plate. New tilting runners, slag ladles and blast furnace gas cleaning apparatus are shown. SE (2a)

New Problems in Iron Metallurgy and Coking (Neue Aufgaben bei der Eisenverhüttung und Verkokung) H. RÖCHLING. *Z. Ver deut. Ing.,* Vol. 82, July 30, 1938, pp. 899-901. Descriptive. Possibilities for developing a continuous process to utilize low-grade Fe ores and to reduce the quantities of slag in the blast furnace are discussed. An experimental plant is described in which the blast furnace Fe runs continuously to one end of a decarburizing and deoxidizing drum from the other end of which steel is removed continuously. Slag is taken off at the (liquid) Fe entrance. So far, 10,000 tons of V-steel have been made; vanadic acid was recovered from the slag. Ha (2a)

Calculating the Coke Consumption in the Blast Furnace in Advance (Die Vorausherechnung des Koksverbrauches im Hochofen) E. SENFTER. *Arch. Eisenhüttenw.,* Vol. 12, Aug. 1938, pp. 49-64. Practical. A Dogger ore with about 20% Fe requires about 125 kg. coke/100 kg. pig Fe. The heat required to heat the charge, the heat given up in wall losses and the heat of combustion of the coke were considered. Sample calculations are given for untreated Dogger ores and for various slags. SE (2a)

The Production of Ferrosilicon (Beiträge zur Ferrosilizium-Gewinnung) ERICH LIEBSCHER. *Metall u. Erz,* Vol. 34, No. 19, 1937, pp. 502-507. Discussion. Wrought Fe and P-free scrap Fe in the form of punchings, chips, etc., pure quartz and a special loose, porous and active coke, all of the best quality, are used. The viscous slag formed during melting facilitates the desired reactions. Casting recommendations are given. PCR (2a)

2b. Non-Ferrous

The Nkana Copper Refinery of Rhokana Corp., Ltd. ARCHER E WHEELER & HENRY Y. EAGLE. *Trans. Electrochem. Soc.,* Vol. 74, 1938, Preprint No. 19, 24 pp. Descriptive. This refinery in Northern Rhodesia, built at a cost of $2,000,000, is the first electrolytic refinery built in Africa. It has a capacity of 100 tons a day. Nkana blister Cu assays 99.3% Cu. The precious metal content is low. Because of its high Bi content (0.007%), which could not be effectively reduced by smelting, electrolytic refining was necessary. *Anode department:* The anode furnace is cylindrical, 30 ft. long and 13 ft. in diam. It delivers refined blister Cu, via a hydraulically operated pouring spoon, to a Walker wheel, 24 ft. in diam. Mould temperature is regulated by water sprays. *Electrolytic tank house:* The house contains 416 tanks, made of pre-cast concrete slabs lined with 6% antimonial sheet Pb. 26 of the tanks are used for preparing starting cathode blanks. A tank contains 32 anodes and 33 cathodes spaced 4.5 in. apart. All tanks are connected in series, and require 65-70 volts for the current supply of 9,000 amp. The current density is 15 amp./ft.^{2}, and the temperature is 56° C. 17-18 days are required for forming cathodes. A portion of the electrolyte is purified at regular intervals. *Furnace refinery:* The refining furnace for melting the electrolytic Cu is of the reverberatory type with a hearth 40 x 14 ft. and a capacity of 250 tons. The Cu is cast on a 38 ft. diam. Clarke type casting wheel. Finished shapes are delivered to an inspection conveyer. Three bars from each furnace charge are analyzed and conductivity measurements are made. AB (2b)

Interaction between Silicates of Nickel and Sulphides of Iron and Calcium in Melting. D. I. DERKACHEV & A. A. ZEIDLER. *Tsvetnye Metal.,* No. 7, July 1938, pp. 66-71. In Russian. Laboratory experiments confirmed the views previously published by W. JANDER (*Z. anorg. allgem. Chemie,* Vol. 172, 1938, p. 129) and other investigators in regard to the possibility of melting oxidized Ni ores with pyrite or sulphides of Ca in refractory furnaces. The reactions $NiSiO_3 + FeS \rightleftarrows NiS(Ni_3S_2) + FeSiO_3$ and $NiO + FeS \rightleftarrows NiS(Ni_3S_2) + FeO$ go almost completely to the right, the equilibrium constant for the first reaction being $0.49\ 10^{-2}$ to $0.84\ 10^{-2}$. Addition of CaO and CaF_2 has little influence on the constant. Addition of charcoal shifts the equilibrium to the right, i.e. toward slags poorer in Ni. Reaction $NiSiO_3 + CaO \rightleftarrows NiS(Ni_3S_2) + CaSiO_3$ goes to the right even more completely than the FeS reaction. These reactions go to the right both in oxidizing and neutral atmospheres; in reducing atmospheres the reactions are complete and the slags are free from Ni, *i.e.* all Ni is converted into sulphide form. 10 references. BND (2b)

Cathodic Processes in the Electrolysis of Cryolite-alumina Melts. A. I. BELYAEV. *Tsvetnye Metal.,* No. 7, July 1938, pp. 87-93. In Russian. Original research. Experiments were conducted to determine whether, in the electrolysis of cryolite-Al_2O_3 mixtures, the dissociation of Al_2O_3 and AlF_3 forms Al^{+++} ions, which are deposited on the cathode, or whether this is preceded by the deposition of Na, with the deposition of Al following as a secondary reaction. Decomposition potentials of melts of Na_3AlF_6 + 15% Al_2O_3, K_3AlF_6 + 15% Al_2O_3, and Li_3AlF_6 + 7% Al_2O_3 were in all cases equal (2.20 at 950° C. and 2.01 at 1080° C.), and thus not dependent on the nature of the cryolites used, indicating that the cathodic process is essentially the primary neutralization of Al^{+++} ions. The decomposition potentials of pure Na-, K-, and Li-cryolites at 1080° C. were 2.07 volts for Na_3AlF_6; 2.13 for K_3AlF_6, and 2.20 for Li_3AlF_6. BND (2b)

Trail Solves Its Sulphur Problem. S. D. KIRKPATRICK (Staff) *Chem. & Met. Eng.,* Vol. 45, Sept. 1938, pp. 483-485. Descriptive. Consolidated Mining & Smelting Co. of Canada, Ltd., now recovers elemental S from the gases obtained by roasting the Pb and Zn flotation concentrates. The gas is purified and SO_2 is reduced to S by incandescent coke. The product is the 99.99% brimstone of commerce. PRK (2b)

3 · MELTING, REFINING AND CASTING

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Important Facts on Molding Sands (Wichtiges über Giessereisande) *Giessereipraxis,* Vol. 59, June 19, 1938, pp. 243-245; July 3, 1938, pp. 263-265; July 17, 1938, pp. 283-286. Practical. Considers in detail all points of importance for suitable molding sands and the defects in castings unsuitable molding sands may cause, particularly the necessity of providing sufficient permeability. American preference for synthetic molding sands would be unjustified for German conditions, since they offer neither economic nor practical advantages. The requirements of synthetic molding sand-binders are discussed. Experiments with a new patented binder "Geko," marketed by O. Ullrich, Leipzig, permitting unlimited regeneration of old sand and reimparting plasticity to sands that have become unplastic, are outlined. The following table shows the improvement that may be obtained:

	Old, unfit sand	Same sand +1% "Geko"
Gas permeability	14.2	21.6
Compression strength, g./cm.²	337.0	940.0
Shearing strength, g./cm.²	103.0	220.0
Water content, %	8.38	8.38

GN (3)

Modern Core Making (Die moderne Kernherstellung) OTTO BRAUER. *Giessereipraxis,* Vol. 59, Jan. 2, 1938, pp. 4-7; Jan. 30, 1938, pp. 41-44; Feb. 13, 1938, pp. 61-63; Feb. 27, 1938, pp. 81-85; July 31, 1938, pp. 306-309. Practical. Comprehensive discussion of faults in core manufacture and of measures and devices to avoid such defects. Those considered are: Making of cores in boxes, green sand and oil sand cores, sand drying equipment, core making with core blowing machines, heavy cores made with turnover core molding machines, and rotating core making machines. GN (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

Theoretical and Practical Significance of Graphitization in Cast Iron. E. PIWOWARSKY. *Foundry Trade J.,* Vol. 59, Sept. 8, 1938, pp. 181, 184. Review. Besides its good fluidity and machinability, gray cast Fe possesses certain specific properties that ensure its preferred position among casting materials, despite the keen competition of new materials on a light-metal or synthetic resin basis. These properties include wear-resisting capacity, high compressive strength, good vibration damping power, high notch strength, relatively high fatigue strength, elastic resilience, corrosion resisting properties, good adhesion of oxide and scale films, etc. etc. As it is nowadays generally possible to produce sand-molded cast Fe systematically with 3-3.3% C and 1-2% Si and with wall-thicknesses of 0.4-1.2 in. having strength of 24 tons/in.², it does not appear necessary to reduce the C content below about 2.7-2.8% for mechanically high-grade castings. Any further increase in the efforts solely in the direction of an increase in strength is not necessary and may damage the foundry industry. It is furthermore obvious that for many purposes where an unalloyed Fe will serve, an alloy cast Fe should not be stipulated. Cast irons with 2.7-3.4% C are and should remain the most important from the viewpoint of manufacture and use. Concerning deoxidizing ladle additions in the form of Fe-Si or Al alloys, the author observed in electric furnace melts a fairly constant increase in the strength figures. Under slags rich in lime or alumina, and with considerable superheating of the bath in the electric furnace, it is quite possible to attain tensile strengths of 19-24.5 tons/in.² with 3-3.2% C. According to W. O. Ruff (*Metals and Alloys,* Vol. 5, May 1934, p. MA 180) and P. Bardenhauer & A. Reinhardt (*Mitt. Kais. Whilhelm-Inst.,* Düsseldorf, 1936, No. 6) low-oxide silicate slags, particularly in the case of low-C melts, promote the formation of an exceedingly fine graphite eutectic, while slags richer in oxide tend to produce normal crystallization of the graphite without excessive supercooling. AIK (3a)

Gas in Steels. Experiments with Gases Discharged During Pouring (Gaz dans les Aciers. Expériences sur Gaz Degagés Pendant la Coulée) G. MORESSÉE. *Rev. Universelle Mines,* Vol. 14, Sept. 1938, pp. 677-687. Research. Liquid converter steel contains 10-15 times its volume in gases (volume referred to normal temperature and pressure) which, in general, consist of ⅔ CO + CO_2, and ⅓ H and N. Experiments were made to determine the amount of gas escaping during pouring and the amount of gas remaining in the steel. The method of determination is described in detail and the results are summarized in the following table:

	Gas in l./ton of steel			Composition of gas, %		
	$CO+CO_2$	N_2	H_2	$CO+CO_2$	N_2	H_2
Bessemer steel, very soft, not killed	224.0	37.6	34.1	74.9	12.6	11.4
Bessemer steel, soft, not killed	149.6	47.6	6.6	62.3	23.0	3.2
Bessemer steel, soft, not killed, agitated	149.7	31.1	6.3	78.8	16.9	3.3
Bessemer steel, soft, killed	8.0	43.2	17.3	11.6	62.4	25.0
Open-hearth steel, soft, not killed	177.6	27.2	7.5	82.9	12.7	3.5
Open-hearth steel, killed	2.1	31.1	0.2	5.9	87.8	0.5
Bessemer steel, hard	0.2	4.9	0	3.3	86.8	0.0
Open-hearth steel, harl.	0.8	16.9	0.5	29.8	67.7	2.1

Besides these gases, O_2 and CH_4 also have been found, but in very much smaller quantities. The gases have a very different rate of discharge: That of N_2 is most rapid at the beginning of pouring and then diminishes quickly; that of CO is small at the beginning, increases to a maximum and then diminishes again; H_2 behaves like CO_2, but the maximum is much less pronounced. This gives, for the same steels, in the order in which they appear in the table, as 6.79, 1.84, 6.58, 4.13, 18.93, 1.93, 5.66, and 1.05 l./ton. The time for the escape of the gases was measured, and given, in l./ton/min., 13.18, 14, 11.26, 3.98, 12.11, 3.70, 1.12, and 1.82 repectively. Ha (3a)

Heat Content and Heat Capacity of Slags of the System SiO_2-CaO-FeO. B. P. SELIVANOV & V. M. SHPEIZMAN. *Metallurg,* Vol. 13, Feb. 1938, pp. 26-34. In Russian. 4 groups of slags were used: (1) 24-25% SiO_2, 0-40% CaO and balance Fe oxides. (2) 30% SiO_2, 0-50% CaO and balance Fe oxides. (3) 40% SiO_2, 0-43% CaO and balance Fe oxides, and (4) 50% SiO_2, 0-35% CaO and balance Fe oxides. In each group the sum of CaO + FeO was constant. 2 heat content measurements were made below, 2 above, and one at the melting point. At temperatures up to the melting point, the heat content of various slags changes very little. By increasing the CaO to 20%, the heat content of the last 3 groups drops somewhat; a further increase of CaO from 20 to 50% causes a rise in the heat content. This was not observed in slags of the first group. Above the melting point the heat content of various slags is different because of their differing tendency to crystallize. All the slags consisted of crystalline and vitreous components. If the chemicial composition of the slag is nearly the same as that of an easily crystallizing chemical compound, then the heat content will increase with a rise in temperature. Slags that do not have this chemical composition, but crystallize easily, will have the same or a slightly lower heat content with a rise in temperature. Such behavior is due to the varying proportions of crystalline and vitreous parts. In general the heat content of the slags is not an additive function, but depends much on the mineralogical composition. The melting point of $2FeO.SiO_2$ was 1210°. BZK (3a)

Melting Tests with a Line Frequency Induction Furnace (Schmelzversuche mit einen kernlosen Netzfrequenzofen) G. MARS. *Stahl u. Eisen,* Vol. 58, Aug. 4, 1938, pp. 833-840; Aug. 11, pp. 865-868. Melting practice with 25 cycle line frequency induction furnaces and a similar vacuum furnace of about 3-ton capacity is described. There was no difficulty in melting even such fine scrap as thin sheet. Low frequency current is advantageous for heavy scrap and large furnaces; high frequency current for light scrap and small furnaces. The role played by bath agitation by the electric current is discussed. Calculations indicated the efficiency of the furnace was about 57%, this being about as good as for high frequency furnaces. No condensers were required, the furnaces being operated directly on the line current. SE (3a)

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Evolution of Gases from Rimming-steel Ingots. K. C. McCutcheon (Am. Rolling Mill Co.) & John Chipman (Mass. Inst. Tech.) *Metals Tech.*, Vol. 5, Aug. 1938, 21 pp. Original research. Gases were collected from 18 in. x 39 in. ingots by covering the liquid steel in the mold with a welded hood of heavy sheet Fe, which was allowed to freeze into the rim of the ingot. Gases were led out through a steel pipe and rubber hose to a gas meter and sampling valve. Rate of flow was between 2½ and 5 ft.^{3}/min. when the meter readings were begun, and evolution continued for a period of 30-40 min. Total gas evolved after filling the mold ranged from 36-to 74 ft.^{3}, and it was estimated that between 20 and 40 ft.^{3} escaped during teeming. In general, less gas was evolved at 0.09% C than at lower percentages. The gas contained 80-92% CO, 2-14% CO_2, 2-6% H_2, under 3% N_2, and traces of hydrocarbons. As the C content increased the ratio of CO_2 to CO decreased. Samples from liquid metal in adjacent ingots were analyzed for C and O. The ratio of CO_2 to CO in the gas was proportional to the O content of the metal. The C-O product in the liquid metal was 0.0020-0.0028, compared to an equilibrium product of 0.0022 at atmospheric pressure. This indicates that the C-O reaction is very rapid. Gas and metal analyses were used to compute gas pressure within the ingot, which was found to be about 1.4 atmospheres immediately after pouring. Since the ferrostatic pressure in the lower part of the ingot exceeds this figure, the occurrence of the rim blowholes is explained by the inability of localized gas bubbles to grow against the applied pressure. In the upper part of the ingot, free evolution occurs and the bubbles are swept away. JLG (3a)

Desulphurizing Properties of Aluminum in Steel-making Processes. V. Karmazin. *Teoria i Pract. Metall.*, No. 5, 1938, pp. 23-30. In Russian. Original research. Solubility of Al_2S_3 in Fe was investigated by melting the Fe under Al_2S_3 + Al_2O_3 slags, and was found to be quite low. As it decomposes FeS completely, addition of Al can be used for desulphurization of steel in practice. Distribution coefficient between the metal and alumina-lime slags for Al_2S_3 is about 125, so that good desulphurization is possible, provided the metal is well deoxidized. Ten basic open hearth heats were killed with 10% FeSi and FeMn, treated with a Si-Mn-Al alloy and tapped 15-20 min. later. S originally present was cut 30-50%, from 0.025% to 0.010% and from 0.065 to 0.040% S, these being the limits of sulphur range. Al_2S_3 can be determined by decomposition with water and measuring the H_2O evolved. The apparatus and methods employed are described. (3a)

The Economic Importance of Centrifugal Casting (Die wirtschaftliche Bedeutung des Schleudergusses) W. Haken, *Giesserei*, Vol. 25, Aug. 12, 1938, pp. 395-401. Review. After a brief historical sketch of the development of centrifugal casting, its advantages are discussed. These include avoidance of losses through heads, risers and gates; the ability to produce tubular pieces; complete filling of the mold; and absence of segregation. Degasification and increase of nucleation are discussed and examples described for molds and tubular products. The usual composition of centrifugally cast Fe is about 3.4-3.8% total C (3.0-3.50 graphite), 1.6-2.5% Si, 0.4-0.7% Mn, 0.7-1.0% P, and 0.04-0.08% S. The most common position for casting heavy pieces is vertical. Ha (3a)

Slag Regulation in an Open Hearth Furnace. L. Vladimirov. *Stal*, Vol. 7, Dec. 1937, pp. 1-7. In Russian. The length of a steel heat is determined not by the time required for the chemical reactions but by the rate of heat absorption by the steel bath. This rate can be increased by reducing the thickness of the slag during the oxidation period. Theoretical considerations verified by practice show that the length of the heat is a hyperbolic function of the slag thickness, decreasing from 19 hrs. for 200 mm. to 4 hrs. for 25 mm. thickness in the case of a 150-ton furnace. HWR (3a)

3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Metal Castings (Ausschuss durch Gase im Schwermetallguss. Wege zur Verhütung) F. Höhne. *Giessereipraxis*, Vol. 59, Aug. 28, 1938, pp. 347-350. Practical. The effects of H, N, SO_2, O, CO, and H_2O vapor in castings of Cu, Ni and their alloys, particularly rising of the metal in mold and inverse ingot segregation. The remedies to avoid infiltration of gases in melt are discussed: (1) Protection of molten metal by slags, (2) oxidizing melting, (3) suitable furnace type, (4) proper selection of charge, and (5) necessary precautions in molding. If, in spite of the mentioned precautions, the metal should be gaseous, the following is advised: (1) Increased addition of P-Cu, (2) quieting before casting, (3) stirring of some gates or some pieces of Zn into molten metal or of Cl or N. The gas-sensitivity of various non-ferrous metals is touched upon. GN (3b)

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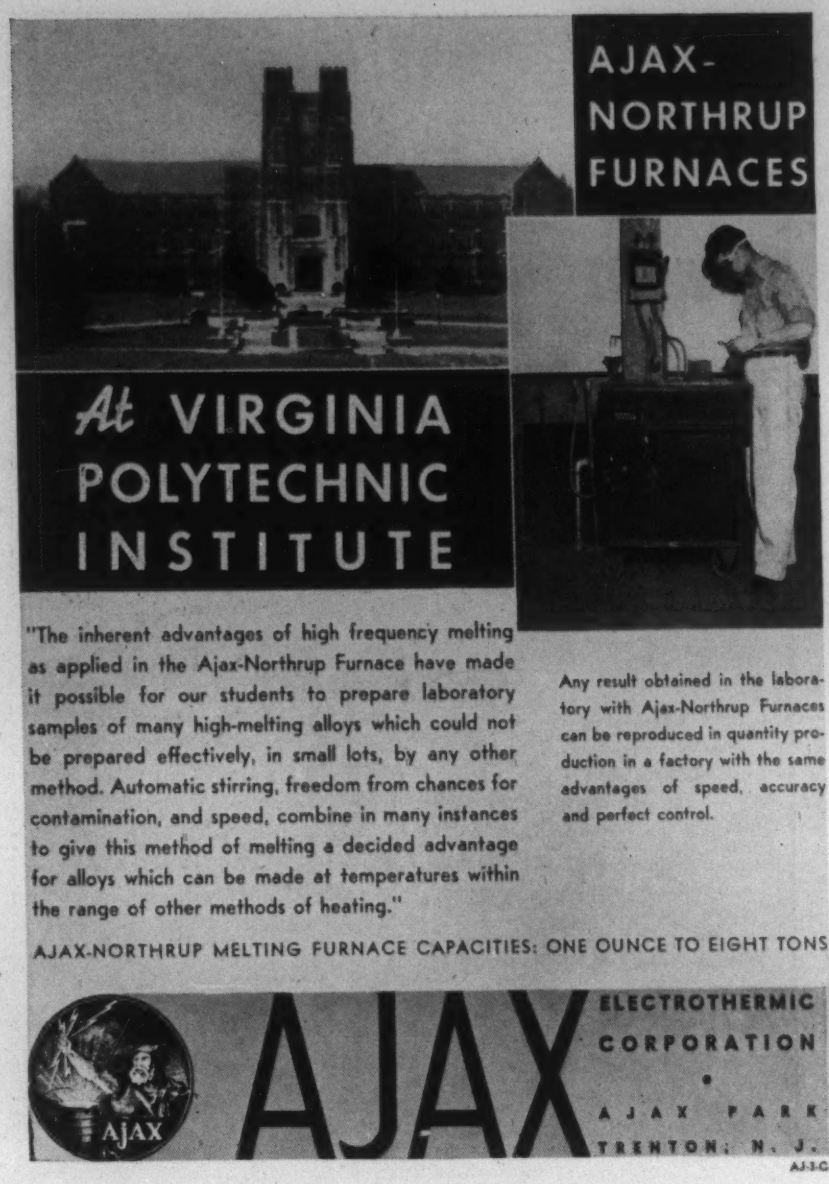
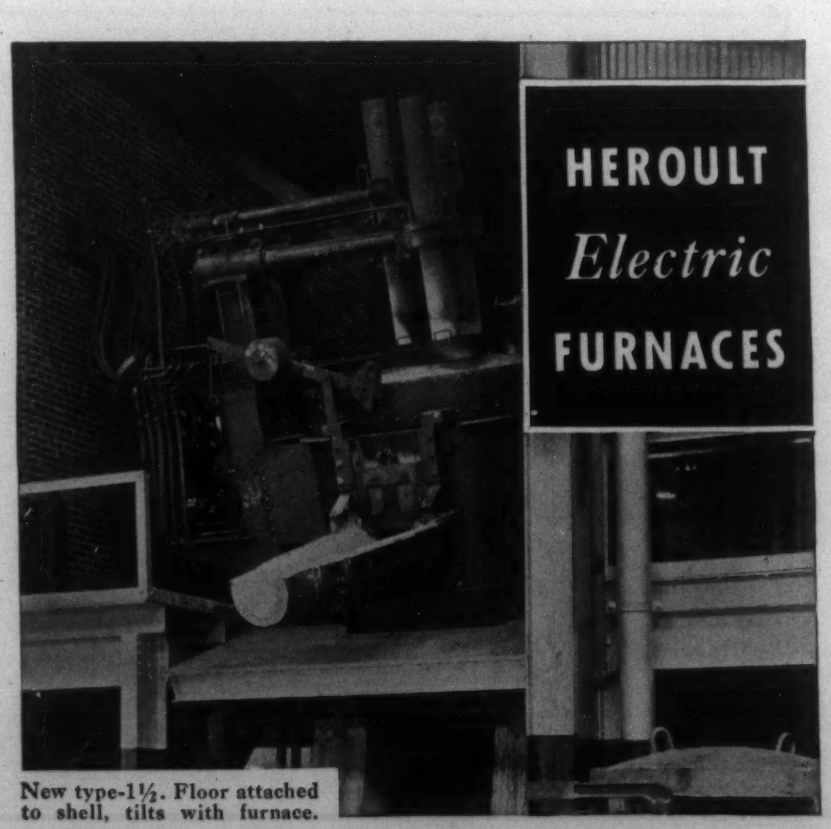
Non-ferrous Foundry Practice. XI. Design and Moulding Practice for Gunmetal. J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 53, Sept. 16, 1938, pp. 273-278. Practical. The successful production of castings depends considerably upon their design. The designer should be fully aware of the foundry difficulties, as only rarely is a special design more advantageous than a design that is easy to cast. The design should avoid abrupt changes of section, avoid sharp corners by a generous use of fillets, and, whenever possible, should not have heavy masses so positioned that they are difficult to feed by ordinary methods. Gunmetal is one of the easiest metals to cast. Small castings are generally made in green sand, and medium to large size in dry sand. The preparation of a mold may be divided into 3 steps: Ramming, finishing and closing. The mold of a small spherical casting presents little trouble. It must be rammed hard but not hard enough to cause scabbing. A hollow casting is more difficult. The cope is as simple as with the spherical mold; the drag offers low resistance to scabbing, as the free escape of gas is restricted; a gas pressure under the mold face puts the surface in tension. Therefore, the drag half must not be rammed so hard as to impair permeability, but must be rammed sufficiently hard to preserve its shape. On small castings, these limits may be wide, but the larger the casting the narrower the limit. These limits may be increased by following certain precautions, such as: The moisture content of the sand must be low, or if the troublesome part of the mold is vented with a wire, it may be rammed harder; skin drying also helps. Molds and cores for bronzes do not usually require as much venting as with cast Fe. Mold surfaces liable to scab should be well vented. The successful production of most non-ferrous castings depends mainly upon correct gating, size and number of runners and risers. Feeding heads are employed chiefly on pressure castings, primarily to ensure sufficient feeding of the upper part of a casting, a secondary use being that of keeping the top face free of dirt. The design of the runner bush of small gunmetal castings is not of vital importance. It must be clean and free from loose sand. Gunmetal castings are usually run quickly, so that, in making heavy jobs, comparatively large runner bushes should be used to maintain a reservoir of metal and prevent the passage of dross down the gate into the castings. For small work, the use of runner plugs over the down gate is unnecessary if the metal is skimmed first. They are desirable for large jobs. Special care must be taken with their use to ensure proper seating and not permit leakage down the gate while the bush is being filled. For Part X see *Metals and Alloys.* Vol. 9, Dec. 1938, p. MA 704 R 5. RWB (3b)

A New Water Cooled Mold. Casting Non-ferrous Metals Horizontally. SVEN F. ERICHSEN. *Metal Ind., London,* Vol. 53, Sept. 9, 1938, pp. 251-252. Description of a new mold. The principle of water cooled molds has been applied for 25 yrs., during which the basic design has remained unchanged, with improvements directed toward prolonging the life of the mold rather than the quality of the product. Elimination of some of the disadvantages was attempted by incorporating Ni alloy steel cooling plates. These expand considerably when placed in contact with the molten metal, and the center of the slab is subjected to considerable pressure, thus reducing blowholes. The expansion of the Ni steel plate is so great that the decrease in volume in the mold is greater than the contraction in the volume of the cast metal, so that no after-pour is necessary. The Ni steel plates have a shorter life than Cu and are more difficult to keep clean, but slabs of improved quality are produced. To overcome the solidification disadvantages of the old type vertical mold, a new type horizontal mold was developed with good results. In pouring this mold, it is tilted sufficiently to allow the metal to enter smoothly. When there is enough metal in the mold to cover the bottom, it is returned to position, skimmed and covered to prevent oxidation. The base plate of the mold is Cu, water cooled. The frame is heated to ensure solidification proceeding upward from the base plate; this scheme also eliminates metal sticking to the side. By this method the impurities only travel the thickness of the slab to reach the surface and are not entrapped in the center, as in vertical casting. Since the solidification takes place uniformly, no after-pour is necessary. The waste head is also eliminated. Time required for solidification may even be shorter than in vertical molds. The horizontal mold is suitable for most metals and has been used for Cu, brass, bronze, Zn, Sn, Ni, Ni silver, Al and its alloys. RWB (3b)

Cause and Prevention of Spoilage with Green Sand Heavy Metal Castings (Giessausschuss bei Schwermetallnassguss, Ursachen und Beseitigung) E. HELLMANN. *Giessereipraxis,* Vol. 59, Aug. 14, 1938, pp. 327-330. Practical discussion of a suitable choice of molding sand, properties required, sand preparation, stressing in particular the necessity of using, in sand mix, powdered coal of first class quality (lignite is unfit, due to too-high ash content). Examples of defective castings resulting from the use of unsuitable molding sand are considered. Correct arrangement of parts in mold, gating technique, application of too large flasks, proper ramming and core making are also considered. GN (3b)





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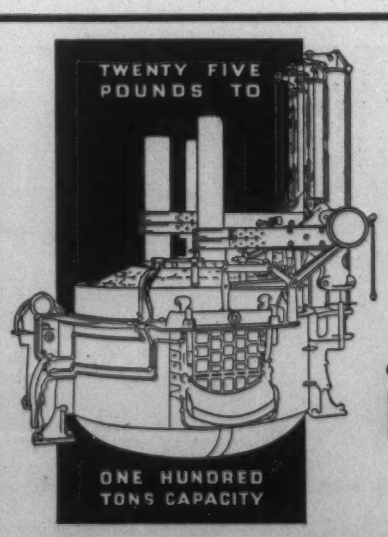

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Magnesium Foundry Practice. W. C. Devereux. *Foundry Trade J.*, Vol. 59, Sept. 22, 1938, pp. 218-219. Review. Melting practice, green-sand castings, sand preparation and control and mechanical properties are discussed. Mg is usually melted in steel crucibles in oil-fired furnaces, although coke furnaces are sometimes preferred. Mild steel does not withstand the action of the fluxes and deteriorates rapidly. The steel should have a low Ni content because of the marked tendency for Mg to absorb Ni from the crucible. Cr and Co are not easily absorbed. It is possible, with extreme care, to melt Mg in a crucible with a closely fitting lid without the use of a flux, depending merely on an atmosphere of sulphur vapor for protection against oxidation. The method is, however, unsatisfactory, and superior results have been produced by the use of fluxes. In German practice 2 fluxes are used (British patent Nos. 219,287), one having a relatively high and the other a low melting point. The metal is heated to a temperature of 800°-850° C. and then cooled to the casting temperature, which is approximately 700°-720° C., the object of the pre-heating before melting being to refine the grain size of the final casting. At the present time it is possible to make satisfactory castings in green sand by the use of inhibitors added to the sand to prevent burning of Mg. In German practice 5-10% S and boric acid are added to the sand, with very good results. In British practice ammonium-bifluoride is used, and when the molten Mg comes in contact with sand containing this fluoride, a coating of insoluble magnesium fluoride is formed on the metal and aids in preventing burning and corrosion. Mg alloys with Al, Mn and Zn are amenable to heat treatment. The heat-treatment of Mg is difficult, owing to the fact that there is a tendency for the alloys to catch fire. The German method consists of carrying out the heat-treatment in a bath of mixed dichromates or in an electric furnace in which there is an atmosphere containing sulphur dioxide. AIK (3b)

Pulverized Fuel for Lead Melting. Automatic Manufacture of Accumulator Plates. *Metal Ind., London,* Vol. 53, Sept. 2, 1938, pp. 219-222. Descriptive. Pulverized fuel has been used for firing furnaces for ferrous work for years, but only recently for non-ferrous. Pulverized fuel furnaces are now being used to replace oil-fired for Pb melting pots, and effect economies in fuel costs of about 45-50%. Such installations are clean and give very fine temperature control. The lower the ash and water contents of the coal the better, from the point of view of furnace efficiency and cleanliness. Coal of smaller slacks than ¾ in. cubes are not recommended. In normal practice, pulverization in order to give 80% —200 mesh is found to answer all requirements. The Pb is melted in Fe pots set on top of the furnace. The burner is fitted at the bottom of the furnace, and an average of 12 lbs. of coal per hr. is used. There seems to be no reason why this process should not be developed and extended to the melting of higher melting point metals than Pb. Its possibilities in the non-ferrous metal industry are manifold and demand further investigation both by the users and the makers of the pulverized fuel plant. RWB (3b)

Crystallization of a Steel Ingot. A. K. Zhegalov & V. M. Tageev. *Metallurg,* Vol. 13, Feb. 1938, pp. 35-49. In Russian. Original research. During the pouring of steel there is formed a thin surrounding crust consisting of very small crystals. The next stage is the formation of a zone of columnar crystals that are oriented in the direction of the heat loss. The slowing down of the crystallization is due to the existence of a "bag" of liquid metal (thermal center). The location of the "bag" depends on the mold shape and cooling conditions. The existence of such a center for a long time enables the non-metallic inclusions to rise and collect in the upper part of the ingot. The crystallization of subsequent volumes of liquid steel differs from the crystallization of the oriented zone. When the mother solution reaches the solidification temperature the crystallization speed increases, the capacity of the mold to accumulate heat decreases, the heat stream loses its previous direction and, as a result, there is formed a zone of disoriented crystals. The various stages of crystallization occur with differing intensities, depending on the shape of the mold. BZK (3b)

The Influence of Melting Conditions on the Structure and Mechanical Properties of Secondary Aluminum Alloys (Ueber den Einfluss der Schmelzbedingungen auf die Struktur und die mechanischen Eigenschaften von Umschmelz-Aluminium-Legierungen) P. Röntgen & H. Winterhager. *Metallwirtschaft,* Vol. 17, Oct. 7, 1938, pp. 1045-1051. Review plus original research. The literature and patents from 1930 to early 1938 on the refining of secondary Al are reviewed. The influence of fluxes and various scavengers as well as type of furnace on the microstructure and physical properties of remelted secondary Al-Cu-Mg, Al-Mg, Al-Si-Mg and Al-Cu-Ni was studied. An induction furnace gave better results than a gas-fired furnace. Of the scavengers, Cl and N seemed to be the best when the material had previously been treated with a flux. $PbCl_2$ is a powerful cleansing agent for the Al-Si-Mg alloys. GA (3b)

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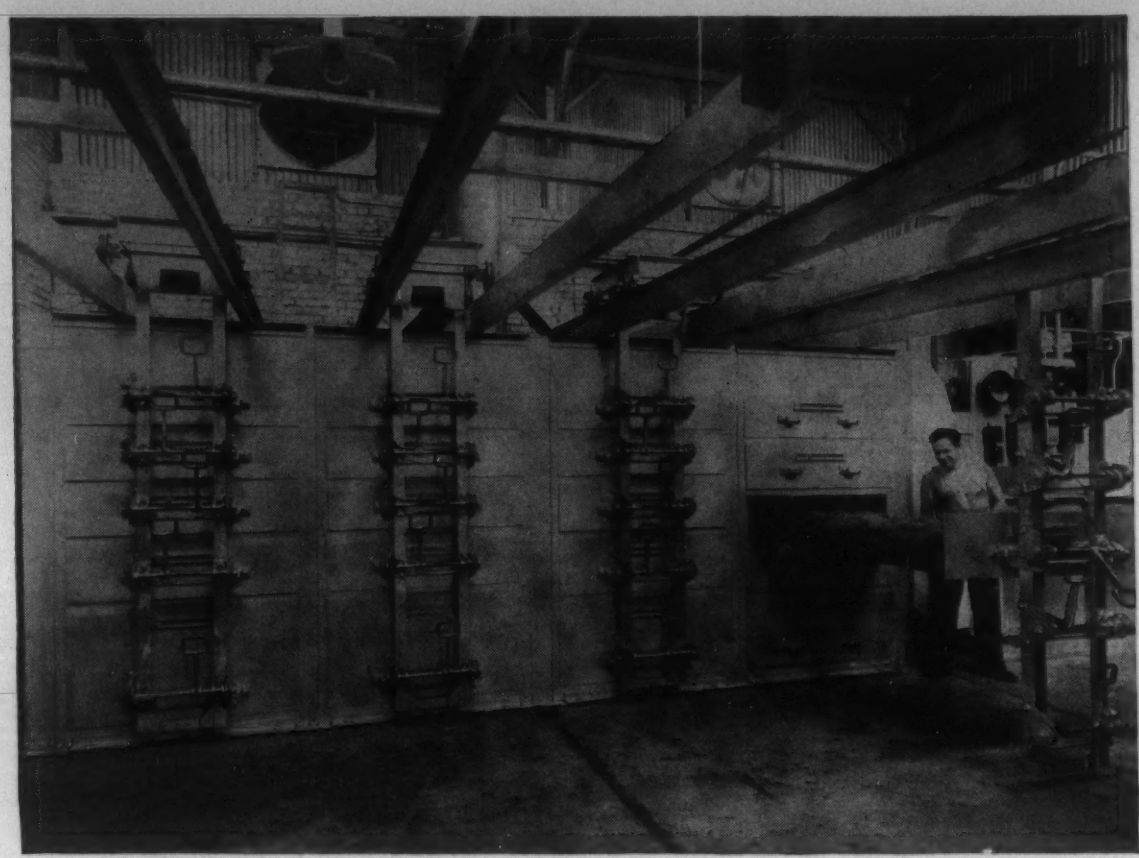

Core oven manufactured by Foundry Equipment Company, Cleveland, Ohio. Photograph, courtesy of The Laclede Gas Light Co., St. Louis, Mo.

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S. EPSTEIN, A. W. DEMMLER AND H. W. GRAHAM, SECTION EDITORS

Cast-to-shape Dies. *Steel,* Vol. 103, Aug. 15, 1938, pp. 62, 64. Descriptive. Strenes metal, a Cr-Ni-Mo alloy iron is used primarily for cast-to-shape forming and drawing dies. It has a minimum tensile strength of 50,000 lbs./in.^{2}, transverse strength of 4,000 lbs., and deflection factor of 0.23, and can be heat treated to a hardness of 525-550 Brinell or 55-60 Rockwell C and to a tensile strength of 75,000 lbs./in.^{2} It is close-grained, takes a high polish, and has excellent graphitic surface lubrication. For die service, it is made in types B and C. Latter is the extremely hard, long-life type. B is slightly softer grade used where long service is less important and is not recommended where maximum hardness is required. This alloy iron saves 30-50% in costs by reducing or completely eliminating finishing, and dies need be polished and stoned only 1/3-1/6 as often as usual. Long life is illustrated by refrigerator top die that is still in good condition after making 750,000 parts. In addition to dies, this iron is used also for its abrasion resistance in sand and gravel chutes, coke crushers, steam-hammer sleeves, and dredging-pumps. This has resulted in 3-4 times usual life. MS (D-4)

The Layout of a Metal Plant. Planning of a Medium Sized Rolling Mill. A. L. MOLINEUX. *Metal Ind., London,* Vol. 53, Oct. 7, 1938, pp. 329-334. Descriptive. The author's experience in the planning and completion of a rolling tube and wire mill of medium size is described, with extensive details as to all of the most important equipment and machinery in the mill. The essential features were: All mills are on one level, each mill having easy access to and from the pickling and annealing shops and to and from each other; auxiliary machinery is grouped to leave wide gangways and ample working room; all heavy machines are independently driven to allow any unit to be run or shut down as required; very few partitions or dividing walls are present, which allows for ease in supervision; and, as far as is possible in an "all-purpose" mill, everything is handled mechanically and in as large units as possible. RWB (E-4)

Some Characteristics of Wire and Their Relation to Cold Heading. H. L. HOPKINS. *Wire & Wire Prod.,* Vol. 13, Oct. 1938, pp. 521-528, 595. Descriptive. The present methods of cold-heading and upsetting, and the influence of them on the surface finish are discussed at length on the basis of publications on this subject. A very important point is the characteristic of the wire between the yield point and point of rupture, as this has a direct bearing on the upsetting process. Grain growth must be prevented as much as possible; by drawing the material beyond the point of critical strain the range in temperature that will produce grain growth in later heat treatment is materially decreased. A table of physical properties of normalized cold drawn wires is appended. 6 references. Ha (D-4)

Influence of Cutting Fluids on Metal Cutting. FRANK J. OLIVER (Staff) *Iron Age,* Vol. 142, Oct. 13, 1938, pp. 141-142, 144, 148, 150-157. Summarizes research work of the special committee on cutting of metals of the American Society of Mechanical Engineers, and includes some hitherto unpublished tests. Traces the accumulation of scientific proof that the chief attribute of cutting fluid is to cool the tool and work, rather than to act as a lubricant at the point of contact. Evaluates the results of research from the point of view of industrial applications. VSP (G-4)

4a. Ferrous

Spreading during the Flat Rolling of Round Steel Wire (Die Breitung beim Flachwalzen von Runddraht aus Stahl) A. POMP, H. HÖHLE & W. LUEG. *Stahl u. Eisen,* Vol. 58, Sept. 1, 1938, pp. 937-943. Original research. The effect of various cold rolling conditions on the "spreading" of different compositions of C steel wire was studied. Spreading increases with the degree of reduction; it is greater in larger diameter rolls. The C content and structure of the wire were without effect. Lubricating the wire and the rolls gave less spreading. The number of passes had little effect. Nomographs are included, showing what the original diameter of the round wire should be to give the desired dimensions after flat rolling. SE (E-4a)

Pressure Machining. *Steel,* Vol. 103, Aug. 8, 1938, pp. 54-55. Describes "Coldflo" process for producing parts comparable in accuracy of dimension and form to those machined from a solid piece of stock. The outstanding advantage is low costs involved. Other advantages are: High strength and hardness, good grain flow, smooth surface finish and an absence of scrap. Bar stock is usually used, and this is flowed cold under extreme pressure to fill contours and cavities of die. In some cases a subsequent draw or forming operation is necessary. Conventional embossing presses of knuckle type are used. Dies are designed and constructed with great care and must have a smooth finish. For general use, they may be made of any good grade of H_2O-hardening cold-header tool-steel. In some cases, cemented WC dies are excellent. Most satisfactory steels for this process appear to be hot-rolled SAE 1010 and 1020, although steels up to 0.45% C and 0.90% Mn have been worked successfully. Non-ferrous metals, particularly brasses, are readily worked. Normalizing removes strains set up if they are objectionable. MS (D-4a)

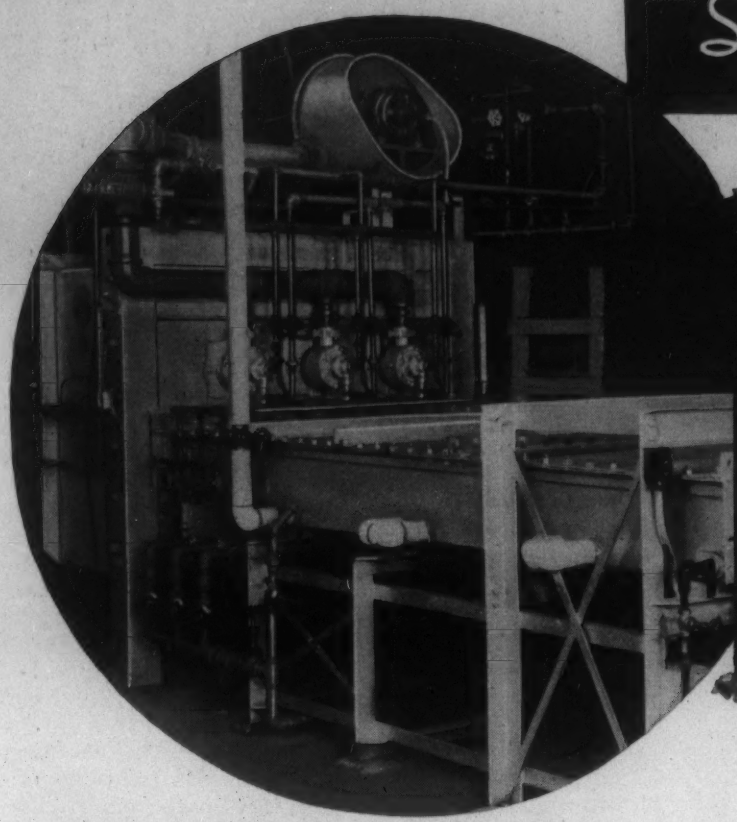
Wire Metallography. B. L. MCCARTHY (Wickwire Spencer Steel Co.) *Steel,* Vol. 103, July 11, 1938, pp. 54, 56-57. Review. Application of metallography to wire manufacture is comparatively recent. Presents examples showing how it helps to prevent mill troubles and to assure uniform high quality. McQuaid-Ehn test has established value of controlled grain size of steel to be drawn into wire. For maximum efficiency and uniform high quality, best results are obtained with coarse-grained material. If a duplex structure is present, patenting treatment can not be adjusted to take care of fine and coarse grain sizes in same rod. Fine grain areas produce thicker cementite plates than coarse grain areas with same rate of cooling. Structure of patented wire, formerly regarded as sorbitic, consists of thin plates of ferrite and cementite. Plate-like formation of Fe_3C is best for wiredrawing. Properly annealed low-C wire has spheroidized particles of globular cementite. In heat treating oil tempered spring wire for valve springs, speeds and temperature should be regulated to produce minimum austenitic grain size. MS (D-4a)

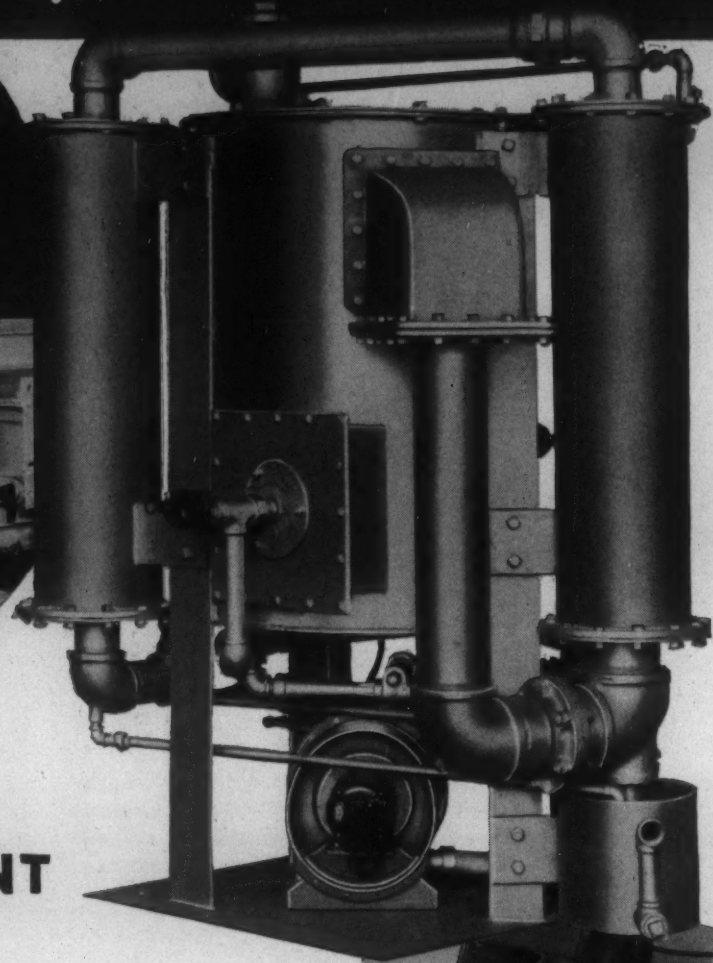
Investigations on the Drilling Properties of Plain Carbon Steels (Bohrbarkeitsuntersuchungen an unlegierten Stählen) H. JANSEN. *Maschinenbau Betrieb,* Vol. 17, Sept. 1938, pp. 455-456. Original research. The C content influences the drilling properties only indirectly, through its effect on the microstructure. The eutectoid carbide of normalized steel dulls the edges of drills rapidly; the machinability is thus reduced with increasing percentage of pearlite. In hyper-eutectoid steels with rather hard pearlite matrix, the ability to hold cutting power is not so markedly reduced by the increase of cementite. Hardly any influence of the C content is noticeable in fully annealed materials. This is explained by the fact that the hard carbide globules are able to back out into the soft pearlite. For shop practice the C content is, therefore, not a good criterion. There is, however, a definite relation between Brinell hardness and the drilling ability factor that holds for the normalized and annealed states. RPS (G-4a)

The Effect of Sheet Width in the Cold Rolling of Steel Sheets (Der Einfluss der Blechbreite beim Kaltwalzen von Stahlblechen) H. BOHR. *Stahl u. Eisen,* Vol. 58, Aug. 18, 1938, pp. 888-890. Original research. Cold rolling of low C sheets of different thickness revealed the relation between varying width of sheet and percentage reduction in thickness, the wider sheet showing less reduction. In austenitic stainless steel sheet, tests showed that with constant rolling pressure the reduction does not change uniformly with the width. SE (E-4a)

Jones and Laughlin's New 96 in. Continuous Hot and Cold Strip Mill. *Iron Steel Engr.,* Vol. 15, Jan. 1938, pp. J-L 1-17. A detailed description is given of the equipment and operating procedure. The entire set-up is covered, including slab supply, furnaces, hot mill, motor room, plate finishing, blue annealing department, coil pickling, cold mills, annealing, cold finishing, galvanizing, lubrication, cranes and service department. A summary of the connected power load is given, totalling 55,222 kv-a. at 6600 volts. A blue-print of the plant lay-out is included. REB (E-4a)

Spencer Turbos at Work





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O. E. HARDER, SECTION EDITOR

Selection of Refractories. B. THOMAS. *Iron & Coal Trades Rev.*, Vol. 137, Oct. 7, 1938, pp. 537-538. Practical review. Factors in selecting a refractory are discussed on the basis of 3 typical furnace operations. Low temperature furnaces for billet-heating, light forgings, etc. from 900° to 1200° C. may advantageously use a "Stourbridge" brick of which 4 typical analyses are given:

	A	B	C	D
Silica	60.52	69.76	58.20	53.80
Alumina	33.81	25.56	34.88	39.21
Iron Oxide	2.22	1.79	3.19	2.72
Titanium Oxide	1.14	1.00	1.90	1.60
Lime	0.65	0.60	0.57	0.30
Magnesia	0.51	0.38	0.51	0.71
Alkalies	1.15	0.85	0.71	1.35
Ignition loss	....	0.06	0.20	0.21

These furnaces are fired either mechanically or manually with solid fuel. High-temperature furnaces for 1750°-1770° C. are heated automatically with pulverized fuel or mechanically stoked solid fuel. Typical analyses of useful refractories for this service are:

	A	B	C
Silica	53.51	51.62	51.29
Alumina	42.44	42.44	42.00
Iron Oxide	2.60	1.89	2.65
Titanium Oxide	1.10	1.47	3.11
Lime	0.40	0.41	0.18
Magnesia	0.50	0.29	0.21
Potash	0.10	0.62	0.63
Soda	Trace	0.22	0.20

For steel-heating furnaces where slagging is a predominant danger, a spinel-base brick is recommended; 2 types are given for temperatures up to 1450° C., used for heating heavy forgings, etc.:

	A	B
Magnesia	35	39
Chromic Oxide	25	24
Alumina	17	16
Iron Oxide	14	14
Silica	7	5
Refractoriness under load	1560° C.	1600° C.
Porosity	19%	22%

The selection of fuel to be used, and the applications of thermal insulation in metallurgical furnaces are discussed. The most commonly used materials for this purpose are diatomite and diatomaceous silica (melting point, 1590° C) The methods of preparing mixtures and building furnace walls are described. Ha (5)

Remote Temperatures. *Steel*, Vol. 103, Sept. 19, 1938, pp. 63, 141-142. Description of "Rayotube," developed by Leeds & Northrup Co., for determining temperatures of hot objects without contacting or being adjacent to work. In the wide-angle type, which measures average temperature of a comparatively large area, energy from hot body passes through an opening in tube end and is focused upon thermopile element at far end of tube by means of a mirror. When used for measuring furnace temperatures, the instrument is held outside furnace wall and focused upon closed end of a target tube mounted in furnace wall. Narrow-angle type, used for indicating temperature over very small areas, has a lens to focus radiation from hot body upon thermopile at far end of tube. This has the appearance of a telescope mounted outside the furnace and focusing through a hole in the wall on work in the furnace. Temperature differences between furnace and work are eliminated from the control system, increasing accuracy. This device may be used where thermocouples are not practical. MS (5)

Refractory Service Increased Through Study of Problems. S. M. SWAN (North American Refractories Co.) *Foundry*, Vol. 66, July 1938, pp. 29-30, 70. Practical. The following are steps necessary: (1) Determine most likely destructive force acting on refractories; (2) determine other contributing factors; (3) check service factors and their relation to problems; and (4) evaluate data obtained. Considers failures caused by softening at high temperatures, structural changes at high temperatures, spalling, abrasion, slag attack and erosion. VSP (5)

Base-metal Thermocouples: Their Characteristics. M. R. MANDLEKAR & H. N. BANERJEA. *J. Soc. Chem. Ind.* (Trans. & Comm.) Vol. 57, Aug. 1938, pp. 276-278. Original research on the properties of various thermocouple elements for the temperature range 0-800° F. Calibration curves are shown, based on millivoltmeter readings at 50° C. intervals, for the following couples: Ni-Cr-Fe/constantan; Cu/constantan; Fe/constantan; Ni/constantan; Ni/Ni-Cr-Fe; Cu/Ni; Ni/Fe; Cu/Ni-Cr-Fe; Cu/Fe; Fe/Ni-Cr-Fe. Thermocouples with constantan gave a wide e.m.f., but the Fe/constantan couple alone gave a straight line temperature-e.m.f. relationship. The curves for Ni-Cr-Fe/constantan and Cu/constantan, however, approached a straight line very closely, especially above 150° C. These 3 couples can be recommended for frequent and reliable use, but the Fe/constantan and Cu/constantan couples must be restricted to low temperature applications owing to the susceptibility to oxidation of Fe and Cu. Ni thermocouples show irregularity in the e.m.f. curves over the range 250-400° F., but the irregularity is overcome by combining Ni with constantan. Neutral points for Fe/constantan and Cu/Fe couples were determined at 205° F. and 275° F., respectively. AAA (5)

An Internally Heated Electric Salt Bath Furnace—Some Users' Experiences. FRED P. PETERS. *Metals and Alloys*, Vol. 9, Aug. 1938, pp. 183-188. Practical description of Ajax-Hultgren salt bath furnaces installed and operating in 3 plants making machine tools, hardware and engraved dies, respectively, with most satisfactory results. The salt bath in these furnaces is heated by the resistance of the bath to the current flowing between one or more pairs of immersed electrodes. The electromagnetic field produced causes a stirring action in the molten salt that results in very uniform temperature distribution throughout the bath, though the electrodes are located outside the working space. The chief advantages found by these users are: Improved quality and uniformity of work, longer pot life due to internal heating, flexibility, cleanliness and comfort in the hardening room. WLC (5)

Foundry Refractories. W. J. REES. *Foundry Trade J.*, Vol. 59, Sept. 29, 1938, pp. 239-240. Although certain of the siliceous materials have a comparatively low refractory value in comparison with aluminous materials and high-silica materials, such as silica brick used in the open-hearth furnace roof, yet they may show some useful properties. Because of their comparatively low refractory value they will tend to glaze over at only moderately high temperatures, and the production of the glaze may retard corrosion and erosion. Thermal changes, physical changes, raw materials for cupola ganister, the bonding material, fireclay considerations, influence of crushing, water additions, general properties, etc., are discussed. AIK (5)

Experimental Determination and Calculation of Combustion Temperatures and their Application to City Gas (Experimentelle Bestimmung und Berechnung der Verbrennungstemperaturen und ihre Anwendung auf das Stadtgas) G. RIBAUD. *Gas-u. Wasserfach*, Vol. 81, Sept. 10, 1938, pp. 661-666. Review plus research. Tables are given and formulas developed to calculate the combustion temperature, theoretical and actual, from the heat contents of the gases involved. Tables show the combustion temperatures for H_2, CO, CO + H_2, CH_4, C_3H_8, C_4H_{10}, C_2H_2 and C_6H_6. Ha (5)

Electric Furnace Design. ROLLAND R. LAPELLE (Continental Ind. Engrs., Inc.) *Steel*, Vol. 103, Sept. 19, 1938, pp. 44-46, 48, 127-128, 130, 133. A summary of methods of calculation, with numerical values in form of curves and tables, affording a simplified system for design of electric furnaces for heating metals within the temperature range 450°-2100° F. All figures are reduced to electrical units. Curves for total losses show actual losses obtained by test on a large number of typical furnaces under operating conditions. MS (5)

Refractory Products in the Steel Mill (Les Produits Réfractaires dans les Aciéries) D. PETIT. *Rev. Mét.*, Vol. 35, July 1938, pp. 296-309. Discussion of refractories used in basic open-hearth, Bessemer, arc and pit furnaces, with emphasis on the increasing use of magnesite and chrome magnesite. Suitable construction of chrome magnesite roof for an open-hearth is described. Refractories and design of ladles are considered in detail. See also *Metals and Alloys*, Vol. 9, Nov. 1938, p. MA 648 R/5. JZB (5)

A NEW TYPE OF GAS FIRING

This announcement concerns a heat-producing method which has been successfully applied to a variety of industrial heating processes.

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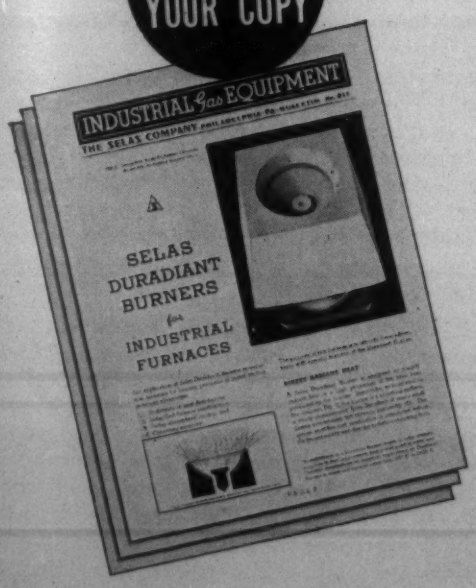

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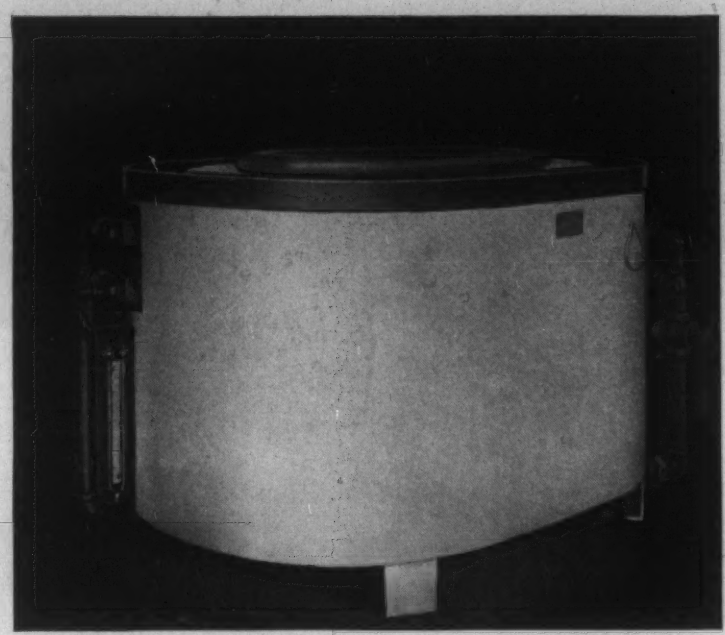

Model GR-2

Pot. 24" long, 12" wide, 17" deep.
Four burners with down draft firing.

JUTHE Pot Furnaces are designed for lead hardening, cyaniding, liquid nitriding, drawing, and reheating operations.

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5a. Ferrous

O. E. HARDER, SECTION EDITOR

Gases for Controlled Atmospheres—Requirements for Purification. E. E. SLOWTER & B. W. GONSER (Battelle Mem. Inst.) *Metals and Alloys,* Vol. 9, July 1938, pp. 163-168. Original investigation. Discussion of previous work on the harmful effects of moisture and CO_2 in protective gas atmospheres (*Metals and Alloys,* Vol. 9, July 1938, p. MA 424L/2) shows the difficulty of removing the last traces of CO_2. The present article determines the limiting amount of CO_2 that can be tolerated, and the utility of small additions of CH_4 in counteracting CO_2. A dry charcoal producer will yield 32% CO and 0.5% CO_2, which is decarburizing to 0.70% C (and higher) steel. The addition of 1.0% CH_4 reduces decarburization to a negligible amount. In partially-burned fuel gas atmospheres a CO_2 content of 0.2% seems to be the equilibrium value; the gas, if it originally contained 0.2% CO_2, remains unchanged in composition after passing through the furnace. Additions of CH_4 displace the character of the gas only slightly in the direction of carburization. The requirements for purification thus appear to be elimination of H_2O and a reduction of CO_2 and H_2 content to such values that any H_2O formed is counteracted by the presence of CH_4. For dry producer gas, 0.5% CO_2 and for partially burned fuel gas 0.2% CO_2 can be tolerated, and an atmosphere produced that is non-decarburizing to high C steel with addition of small amounts about 1.0% of CH_4. H_2 with small amounts of CO_2 made neutral to high C steel with CH_4 will be more carburizing to low C steel than dry producer gas. This is also true of H_2-N_2 gas that is neutralized with CH_4 to overcome the decarburizing effect of H_2. WLC (5a)

Factors Affecting Grain Growth in Annealed Rivets. R. W. SANDELIN. *Wire & Wire Prod.,* Vol. 13, July 1938, pp. 344-353; Aug. 1938, pp. 399-404; Sept. 1938, pp. 455-458. Original research. The treatment of low-C steel rivets required to obtain a softness sufficient for easy upsetting and yet to produce sufficient strength is investigated and the structural changes involved are discussed in very great detail. Abnormal grain growth in annealed low-C rivets results principally from the combined effects of extent of cold-working on the wire, and temperature and duration of the annealing process. Grain coarsening in heat-treatment occurs mainly in the outer portions of the shank, while under the head a relatively small section of smaller size grains is formed. The effects of exaggerated grain growth are eliminated with resulting grain refinement by heating the rivets to 1650° F. or higher. As the strain existing in a rivet is a function of the amount of reduction by drawing, it is possible to adjust the amount of cold-working to a degree where no grain coarsening will occur in subsequent annealing operations. The ill effects of grain coarsening do not make themselves felt until the whole or nearly the whole shank section is affected by it, when strength is somewhat reduced. Numerous microphotographs and hardness curves illustrate the article. 9 references. Ha (5a)

Effect of Heat Treatment on the Yield Point of Special Steels. N. YAMAMOTO. *Nippon Kinzoku Gakukai-Si,* Vol. 2, July 1938, pp. 341-351. In Japanese. Original research. The yielding phenomenon was studied with low Ni-Cr steels, 3% Ni-Cr steel, Ni-Cr-Mo steel, Cr-Mo steel and C steels. When low Ni-Cr steel and 3% Ni-Cr steel are tempered at about 70° C. below the Ac_1 point, the stress-strain diagram shows the same form as that of low-C steel, but when those steels are tempered at about 20° C. below the Ac_1 point, no yield point could be observed. Yielding takes place after a lower tempering temperature as C content increases, and the form of stress-strain diagram does not change with length of heating time at tempering temperature nor by cooling velocity after tempering. The yield point of Ni-Cr-Mo steel and Cr-Mo steel does not disappear after tempering just below the Ac_1 point. Mo seems to prevent the disappearance of yield point. The yield point of the C steels does not disappear by tempering just below the Ac_1 point. Low Ni-Cr steel double-quenched and tempered also shows yielding phenomenon. After low tempering temperature, yielding phenomenon in mildly quenched Ni-Cr and low Ni-Cr steel disappeared. NS (5a)

Flame Softening of Cut Surfaces on Strong Steels. HERBERT H. MOSS. *Metal Progress,* Vol. 34, Aug. 1938, pp. 141-146. Practical. The structure and hardness of structural steel plate is not as severely altered by flame cutting as it is by either shearing or friction cutting. The ductility and toughness is not appreciably affected by torch cutting; torch cutting definitely improves the toughness. This holds true with all low C steels, but with respect to the air hardening steels and higher alloy steels, a hardening effect is produced which is overcome by flame softening by means of a multiple flame follow-up torch. The thickness of the plate being cut will depend upon the size of the post heating flame needed to give maximum softening effect; the thicker the plate the larger the annealing flame should be. For air hardening grades it is essential that this post heat does not exceed the critical point. Proper flame cutting operations will cause grain refinement at the cut edge. WLC (5a)

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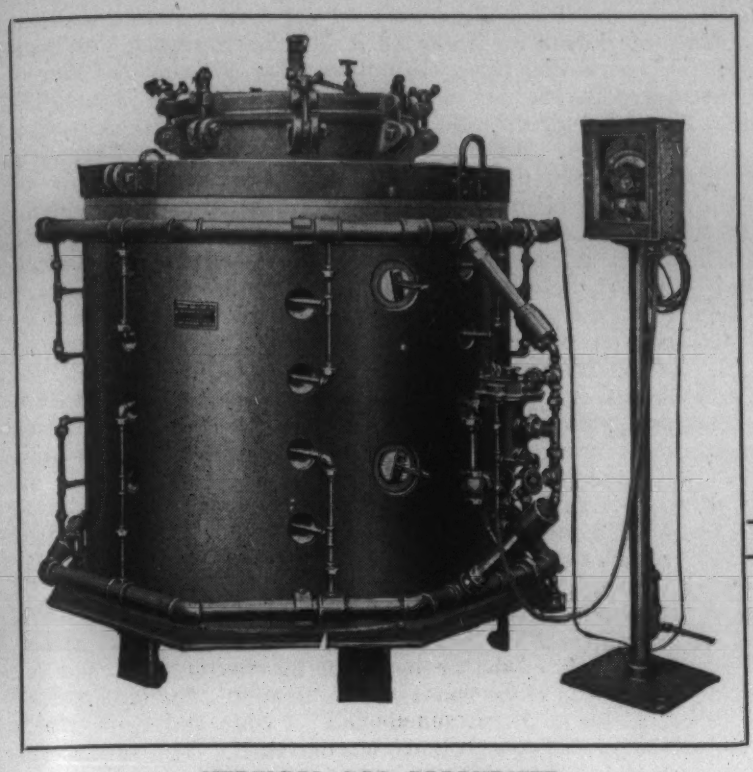

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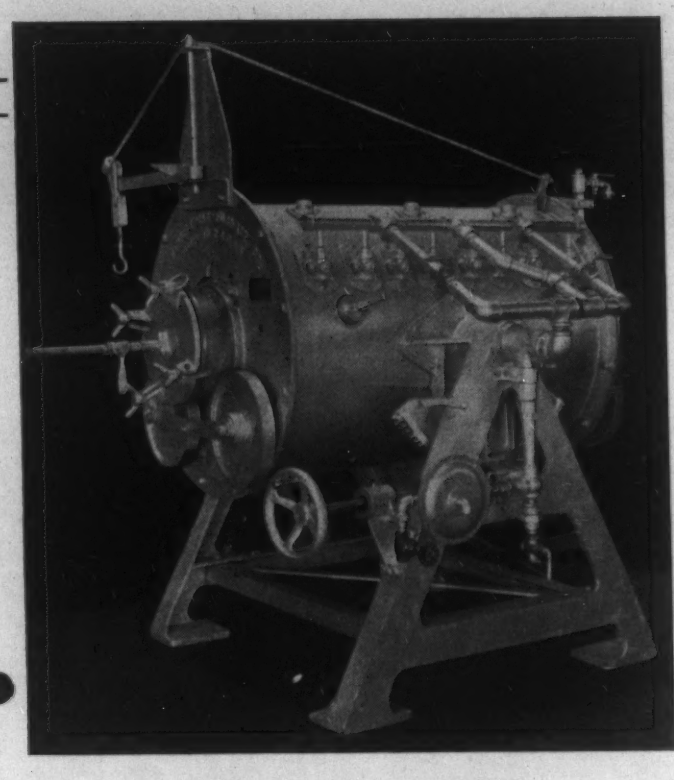

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Notes on Nitriding. V. O. HOMERBERG (Mass. Inst. Tech.) *Ind. Heating,* Vol. 5, Oct. 1938, pp. 917-920. Experiments have shown that nitriding increases the endurance range as determined by reversed bending. Fatigue failures do not begin at the surface but at the junction of the case and the core; the endurance of nitrided parts depends to a large degree on the characteristics of the core. Surface features, such as scratches, notches and threads, have a much smaller effect in nitrided than in unnitrided material. Work of other investigators is reviewed, and means for protecting parts not to be nitrided by plating with Sn or Ni or by painting, are discussed. Ha (5a)

Making Springs. *Steel,* Vol. 103, Sept. 19, 1938, pp. 66, 72. Practical. Describes specialized types of furnaces required in forming and heat treating coil springs. Bars are heated, prior to coiling, to 1650°-1750° F. in long, narrow furnaces. Heating time and amount of scale formed are kept at a minimum, and temperature is distributed uniformly by means of a large number of relatively small soft-flame type burners equipped with air-gas ratio control. Continuous type furnaces, equipped with automatic temperature and air-gas ratio control, heat the formed springs prior to oil quenching. Springs are drawn at 500°-1100° F. in a furnace equipped with a recirculating type of air heater. MS (5a)

The Tempering of Fe Containing Fe Oxide (Sur la Trempe du Fer Contenant de l'Oxydule de Fer) WITOLD BRONIEWSKI & STANILAS MAZGIS. *Compt. Rend.,* Vol. 207, Aug. 1, 1938, pp. 342-344. Original research. O in Armco Fe occurs as Fe_2O_3 at ordinary temperatures, but changes to FeO above 570° C. Because tempering allows part of the oxides to dissolve in the Fe, a study of the change in physical properties due to the presence of O was made after heating samples from 500° to 1450° C. The effect is not regular and must be related to the allotropic modification of the Fe dissolving the oxide, but only in very general fashion. Tempering increases the hardness, tensile strength and electrical resistance, and decreases the elongation and solution potential. FHC (5a)

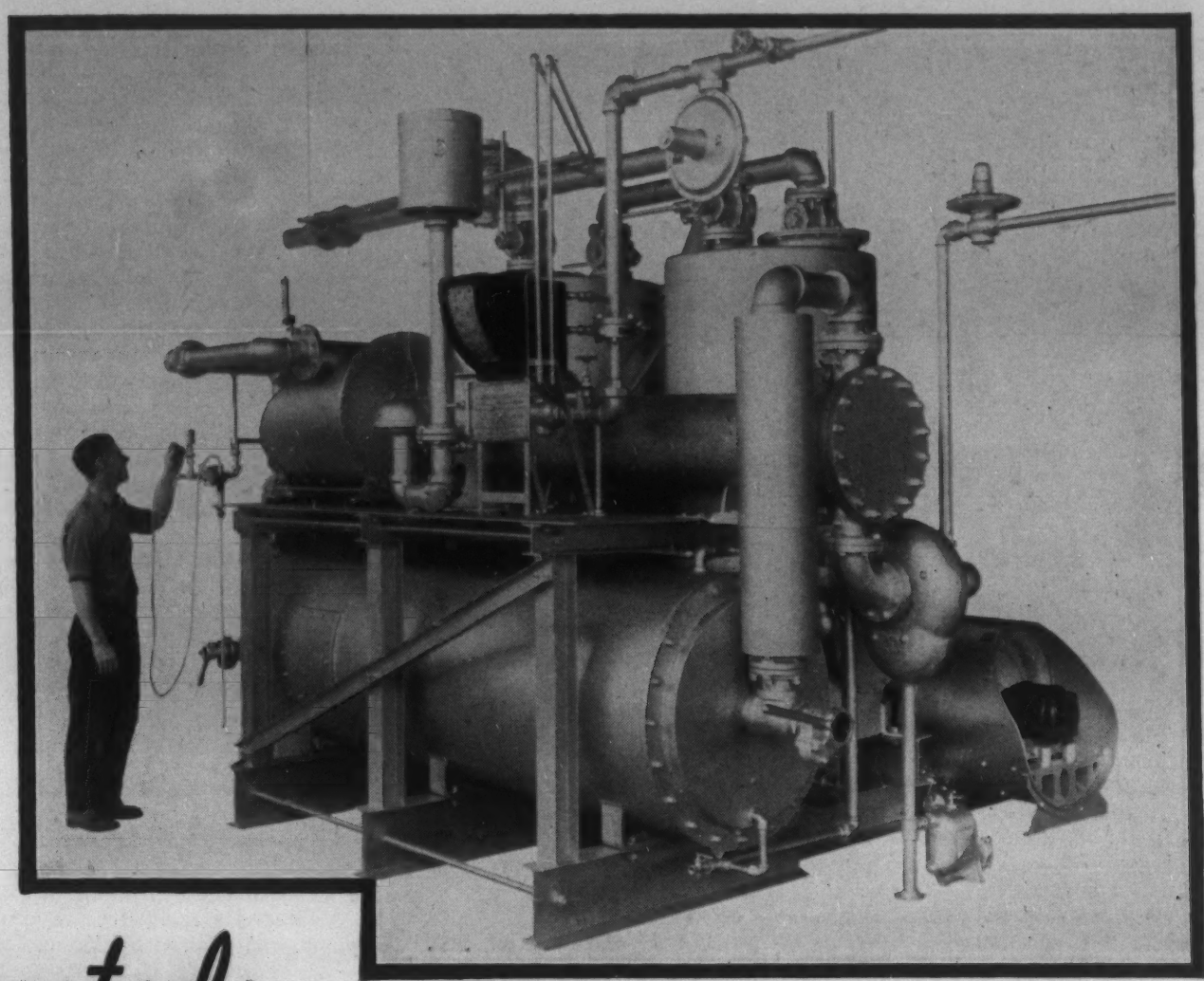
New Furnaces. *Steel,* Vol. 103, July 18, 1938, pp. 42-43. Descriptive. Columbia Tool Steel Co., Chicago Heights, Ill., has installed 3 new gas-fired furnaces for heating ingots and billets for forging. They are of the box type, steel cased and insulated. They embody improvements in combustion-chamber design and in application of burners and controls, giving a flame of definite characteristics. Scale loss has been reduced from 6% to 2.1% of material used. MS (5a)

The Heat Treatment of Special Alloy Steels; The Most Common Processes of Heat Treatment—Noteworthy Points in Heat Treatment of Substitute Steels (Die Warmbehandlung der Edelstähle; die gebräuchlichsten Verfahren der Warmbehandlung—Beachtenswerte Punkte bei der Warmbehandlung der Austauschstähle) H. TREPPSCHUH. *Maschinenbau Betrieb,* Vol. 17, Sept. 1938, pp. 449-453. Review. *Structural steels:* Case hardening steels contain maximum 0.2% C, possibly with additions of Cr, Ni, V, Mo, Cr-Ni, or Cr-Mo. Carburizing temperature should not be too high nor the agent too strong. Failure to observe these precautions has caused difficulties where Cr-Mo steels are used instead of Cr-Ni, because Mo eagerly forms carbides; it produces too high a C concentration, resulting in carbide network, brittleness and pealing on subsequent machining. Special milder carburizing compounds were developed for these steels. The case on Cr-Mo steels is harder, so that a tempering operation at 160-180° C. in oil bath for 1-2 hrs. is necessary to insure ductility of the case and to improve machinability. The advantages of nitriding are: Low temperature (500°-550° C.) and relatively low internal stresses (cooling in air). Disadvantages are: Special alloy steels are needed and the time cycle is longer. Heat treatment at relatively high temp. of the special alloy steels containing 0.25-0.50% C with additions of Mn, Cr, Ni, Mo and V results in excellent physical properties. The hardness penetration is inferior when using Cr-Mo steels as compared with Cr-Ni steels, although the difficulties can be overcome by choosing the material according to the size of the pieces to be treated. For large pieces the addition of Ni is still recommended. Cr-Mo and Cr-Ni steels are equivalent as far as distortion is concerned. The former are highly wear-resistant and, after special heat treatment, quite machinable. *Tool and high-speed steels:* The W content of high-speed steels does not have to be as high as 18%. Steels with 13% W, 4% Cr, and 2.5% V, or 13% W, 4% Cr, and 4.5% V are in use, and the W content may be even as low as 6%. During heat treatment these steels must not be held at hardening temperature longer than absolutely necessary lest toughness be decreased. Simple shapes with short heating-up period can be hardened from 1230° to 1260° C., heavier and intricately shaped tools from 1200° to 1230° C. Drawing temperatures are 520°-540° C. W can successfully be replaced by Mo. A typical composition is: 2% W, 8% Mo, 1.2% V. The heat treatment is different in that heating above 800° C. involves the danger of decarburization, especially in oxidizing atmospheres. Salt bath or controlled-atmosphere furnaces are therefore used for hardening. Maintaining the hardening temperature of 1200°-1220° C. as closely as possible, and holding at heat as short a time as possible, are essential requirements. Drawing at 530°-550° C. produces secondary hardness, just as with regular high-speed steels. [Many of the above points pertain to substitute materials termed "exchange steels," recommended to reduce Germany's import of metals from abroad. It is claimed that most of them are at least equal to standard materials, sometimes with precautions or after special treatment. Restraint seems to be in order when generalizing the results.—R.P.S.] RPS (5a)

Improved Annealing Covers for Tin Plate. *Steel,* Vol. 103, Aug. 8, 1938, pp. 39, 56. Descriptive. New covers for annealing cold reduced strip steel in coils have 3 rows of horizontal, gas-fired, radiant tubes. 2 parallel rows of coils can now be heated instead of one. Each cover has a single exhaust fan which entrains gas for combustion and exhausts combustion products. Coils are placed on bases, and inner covers of light, mild steel sheets are placed over them, in sand seals in bases. Each coil base has a recirculating fan in center and is cored to admit protective atmosphere into inner cover. After all coils are covered, outer cover is placed in its sand seal, burners are lighted, and recirculating fans started. After coils reach annealing temperature, outer cover is removed and transferred to another loaded base. Fans continue in operation until coils have cooled. Mixture of blast-furnace and coke-oven gas containing 300 B.t.u./ft.^{3}, supplied at 20 oz. pressure, is burned. Results are increased tonnage capacity per cover, and faster and more uniform heating and cooling. MS (5a)

The Heat of Formation and Specific Heat of Chromium Nitride. SHUN-ICHI SATOH. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Sept. 1938, pp. 1001-1009. In English. Original research. The specific heat of Cr nitride had not previously been determined . For 3 temperature ranges up to 511° C. the following equations were established: for Cr_2N : $C = 0.1507 - 1.1654 \times 10^{-5}T + 1.2534 \times 10^{-7}T^2$; and for CrN : $C = 0.2096 - 2.328 \times 10^{-4}T + 3.939 \times 10^{-7}T^2$. The following heat of formations of chromium nitrides were determined: $2\,Cr + N = Cr_2N + 26{,}340$ cal., and $Cr + N = CrN + 28{,}260$ cal. EF (5a)

Economies Derived in Using Firebrick Soaking Pit Covers. *Steel,* Vol. 103, July 18, 1938, p. 66. Use of insulating fire-brick in soaking-pit covers results in considerably lighter cover structure; saving in power for lifting and handling; reduced damage to brickwork; less frequent repairs; longer service life; and appreciable fuel savings. MS (5a)



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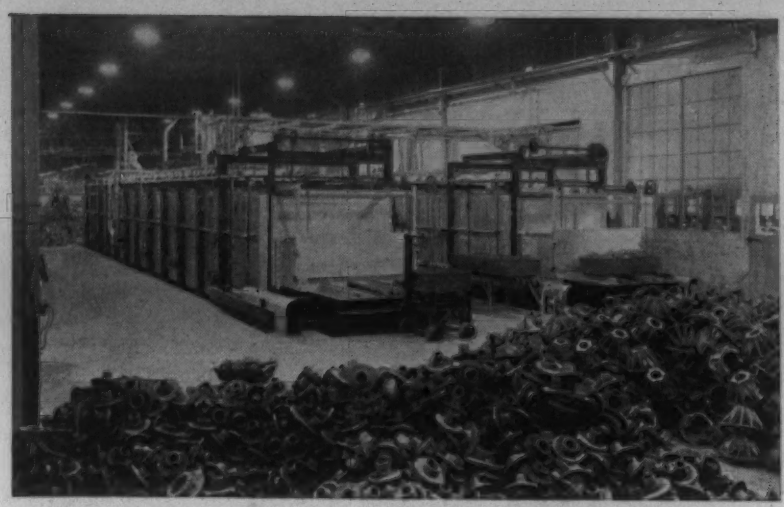

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Heat Treating Wire Machine Parts. J. B. NEALEY (Am. Gas Assoc.) *Heat Treating Forging,* Vol. 24, Sept. 1938, pp. 470-471. Description of furnaces used in plant of Sleeper & Hartley, Inc., Worcester, Mass. Carburizing is done in an oven-type furnace underfired with 10 gas burners divided between 2 sides and staggered, so that alternate streams of hot gases pass each other and flow up and across heating chamber above hearth. Temperatures up to 1800° F. are used in this furnace. C-steel gears, cams, etc., are heated in another oven-type furnace, with temperatures ranging from 1000° to 2000° F. A unique feature is that it contains no fire-brick except in hearth. Walls, top and bottom are of 9 in. of insulating refractory inclosed by a steel case. The hearth is underfired by a double set of gas burners, for high and low temperatures. 2 burner nozzles of different capacities, one concentric within the other, are in a single casting. Salt bath with atmospheric ring-type gas burner below pot is used for drawing and tempering work at 300-800° F. Parts requiring hard wearing surface and comparatively soft core are hardened in a cyanide pot that sits in a furnace consisting of 9 in. of insulating refractory within a steel shell. 4 tunnel-type gas burners, equally spaced on furnace wall both circumferentially and vertically, fire tangentially to inside of wall, without flame impingement on pot. Use of refractory insulation results in saving of gas to heat furnaces and to hold them at temperature. MS (5a)

Some Results Obtained with Chrome-magnesite Bricks in Open-hearth Steel Furnaces. A. E. DODD. *Trans. Ceram. Soc.,* Vol. 37, Aug. 1938, pp. 339-342. Original research. Laboratory tests with chrome-magnesite bricks showed remarkable spalling resistance and refractoriness under load. Two service tests were next tried. In the first, the gas ports and blocks of a 70-ton basic furnace were built of the bricks to be tested, set dry and separated by steel strips. After 20 weeks' working, it was observed that at a short distance from the exposed face, the chrome-magnesite had developed a reddish color, quite different from the brownish-purple of the unused bricks, and a crust of magnetic oxide of Fe had formed on the brick surface. In the second trial, parts of the air uptakes of a 200-ton tilting furnace were lined with the bricks. After a campaign of 22 weeks, the bricks had worn from an original thickness of 9 in. to a final thickness varying between 1½ in. and 3 in. This loss by flaking may be due to the formation of narrow zones behind the working face, and if these zones are due to the absorption and migration of slag and impurities, the flaking may be a physical spalling due to differences in the thermal expansion of the zones. GTM (5a)

Strip Annealing. J. B. BRUNOT, JR. (Penn. Ind. Engrs.) *Steel,* Vol. 103, Aug. 22, 1938, pp. 45-46. Descriptive. Several troubles encountered in annealing high-alloy strip steel, such as 28% Cr or 18% Cr-8% Ni, were overcome by use of a semi-muffle type continuous furnace, gas-fired with automatic fuel-air ratio. Pickling fumes are excluded by use of sealed-in burners using air drawn from a distance from pickle room and maintaining furnace at a positive internal pressure, or by locating pickling equipment in a separate room which retains fumes. Semi-muffle type permits rapid heat transfer to work and is less expensive in first-cost. Atmosphere is controlled by carrying furnace at positive pressure and maintaining constant fuel-air ratio at all operating rates. Exhaust flues in roof are used only during light-up periods. When furnace is operating, combustion products are exhausted through door openings. Rolls built of specially prepared refractory material over a solid steel shaft are provided at inlet and outlet of furnace. Full-muffle furnace, in which strip passes through furnace in an atmosphere of air, has also been used successfully for annealing alloy strip. In this case, burners are set for most economical rate of combustion. MS (5a)

New Carburizing Methods for Iron and Steel. (Neue Zementierverfahren für Eisen und Stahl) KALPERS. *Tech. Blätter.* Vol. 28, July 24, 1938, pp. 434-435. Description of several new methods: Application of special carburizing pastes; addition of asbestos to the liquid baths to avoid decarburization; improvement of cyanide bath by additions of SiO_2, boric acid or SnO_2 to bind the alkalis formed by decomposition of the cyanides; carburizing bath applying neutral salts; use of dispersed C and caustic alkalis, making possible short carburizing time; and baths with carbides of the alkaline earths as carburizers. GN (5a)

Atmosphere Control in Annealing Malleable Iron. E. G. DE CORIOLIS & R. J. COWAN. *Ind. Heating,* Vol. 5, Sept. 1938, pp. 786-788, 834. Descriptive. Methods for preventing or retarding decarburization, and the proper use of atmospheres are discussed. The main principle is to secure a correct balance between CO and CO_2 in the malleableizing atmosphere. This is obtained by burning the fuel gas, manufactured or natural, in an enclosed chamber with a controlled proportion of air which can be varied to give as high as 12% CO_2 and no CO, or as low as 5% CO_2 and 10% CO. Continuous and intermittent type furnaces are described; the total annealing time is about 36 hr. in the former, 48 hr. in the latter type. Ha (5a)

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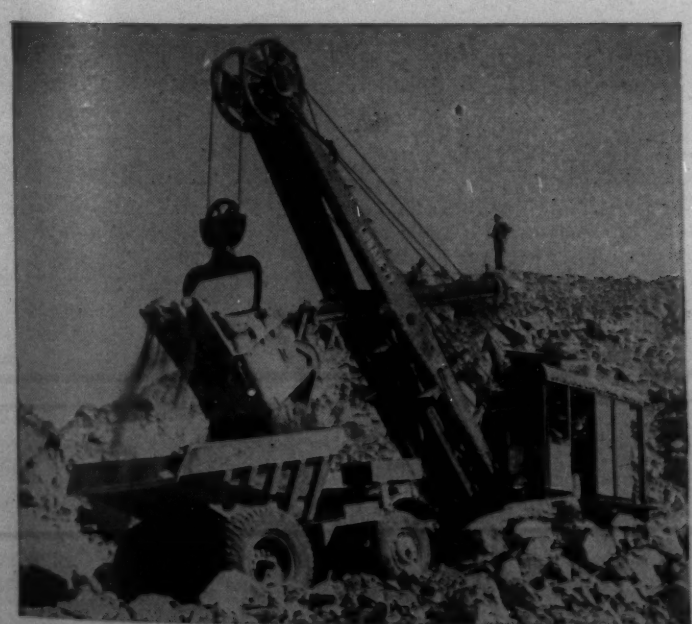

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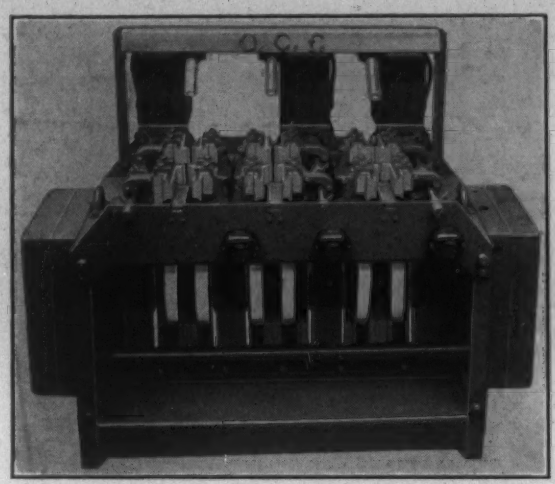

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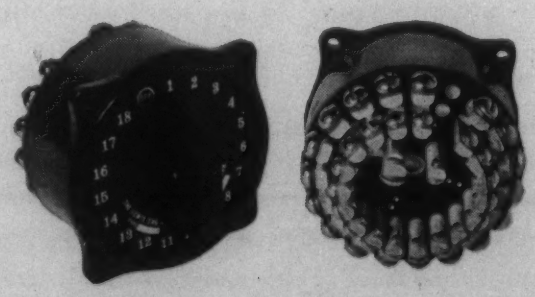

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5b. Non-Ferrous

M. E. MAWHINNEY, SECTION EDITOR

A Description of the Age Hardening Process as Applied to Castings. L. W. KEMPF (Aluminum Co. of America) *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Sept. 1938, pp. 19-40. Review. The possibilities of precipitation hardening as an aid in widening the field of application of castings are discussed. The fundamentals of the process are first considered, using simple illustrations of structural and property changes in pure binary alloys. By reheating the casting to a temperature just below the eutectic temperature for a sufficiently long period, it is possible to attain a saturated solid solution. This equilibrium concentration may be maintained by rapid cooling to room temperature. Because this is a supersaturated structure, there will be a tendency for the alloy constituent or compound to precipitate. The tendency for the precipitation to occur will increase rapidly with increase in temperature. Considerable commercial application has been made of precipitation hardening, particularly in non-ferrous fields. The change in solubility of Cu in Al is the basis for a casting alloy containing about 4% Cu. Tensile strength in the as-cast condition of 22,000 lbs./in.^{2} may be raised to 40,000 lbs./in.^{2} by heat treatment. The solid solubility of Mg in Al varies from about 15% at eutectic temperature to less than 3% at room temperature. Al alloys containing more than about 6% Mg are quite amenable to heat treatment. Other alloys, such as Cu-Cr with 0.5% Cr, Cu-Si with over 3% Si, Cu-Be with 1-3% Be, Al-bronze and Cu-cast irons are mentioned. CEJ (5b)

Change of Elastic Limit of an Aluminum Wire by Annealing. MIYABI SUGIHARA. *Mem. Coll. of Sci., Kyoto Imperial University, Series A*, Vol. 21, Sept. 1938, pp. 145-162. Research. A cold-worked Al wire was heated in an electric furnace, then cooled suddenly to room temperature, and the change of elastic limit measured. The elastic limit decreases with the rise of annealing temperature and annealing time. The plastic elongation of an annealed Al wire and its elastic limit were measured repeatedly after a lapse of certain time intervals. The elastic property is recovered, and, after the lapse of a certain time, the elastic limit becomes somewhat larger than initially. A cold-worked Al wire was annealed, stretched beyond its elastic limit, and annealed again for various time periods at various temperatures. When the second annealing temperature is comparatively low, the elastic limit of the wire increases at the beginning of the annealing period, and in some cases reaches a maximum. This increase of the elastic limit by weak annealing was ascribed to the recovery of the spots of weak inter-atomic cohesion, formed by the previous plastic deformation. HN (5b)

Light Metal Manufacture. Rotary Hearth Furnaces for Continuous Production. ROBERT HAMACHER. *Metal Ind., London*, Vol. 53, Oct. 7, 1938, pp. 345-346. Descriptive. Rotary hearth furnaces, employing forced air circulation for the heat treatment of light metal pressings and pistons, are described. Heating in conventional furnaces fails to satisfy present requirements, for the temperatures required are usually below the temperature of radiation of the heating elements used in the construction of standard electric furnaces. For temperatures under 500° C. heat transfer by radiation to the charge is too low to attain an economically short heating period. Such drawbacks may be definitely avoided by the employment of artificial air circulation, with shortening of the heating-up time. 58 min. were required to heat a piece to 460° C. with the ordinary furnace, but only 23 min. with forced air circulation. A description of a special rotary hearth furnace for heating cylindrical pressed parts is given. RWB (5b)

The Heat Treatment of Magnesium Alloys. L. G. DAY & H. G. HARRINGTON. *Light Metals*, Vol. 1, Sept. 1938, p. 269. Review. Mg alloys containing Al and Zn as the chief alloying constituents are subject to precipitation hardening. Although the tensile properties are improved by heat treatment, it is doubtful if the fatigue resistance is improved. Mg alloys for forging and pressing are not normally age-hardenable, since the alloying constituents in amounts requisite for age hardening do not allow much forming. Special atmospheres for heat-treating Mg alloys are necessary. Certain salt baths are used, but it is usually more convenient to use electric furnaces, or gas-fired furnaces with controlled atmospheres. Unlike Al castings, Mg castings do not require quenching in water and are usually relatively free from distortion and internal stress. AUS (5b)

New "Z" Nickel May Be Heat Treated. *Iron Age*, Vol. 142, Sept. 15, 1938, pp. 39, 49. Describes the application of heat treating to 98% Ni alloy. The "Z" Ni has a strength 2 1/2-4 times that of ordinary structural C steel. It may be heat-treated after fabrication with little if any distortion at temperatures of from 800° to 930° F. for 6-16 hrs. It may be used for hand tools, wire brushes, spring clamps, etc. It is produced commercially as hot or cold rolled strip in a wide range of sizes. VSP (5b)

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Use "Certain Curtain" furnaces proven by 11 years success the world's established leader!

In the late 1920's users of high speed steels found that the new "Certain Curtain" furnaces virtually eliminated the difficulties of hardening tool steels, especially the high speed types. The patented control of furnace atmosphere produced definite results not previously obtainable, such as —

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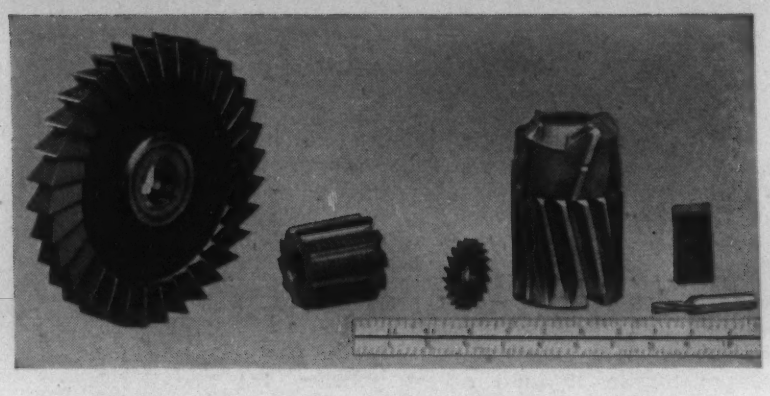
In nearly 900 furnaces installed since their original outstanding success, Hayes furnaces have maintained an unbroken record of lower cost for better tools. Against the background of an almost endless variety of competing equipment, "Certain Curtain" is the only established and proven method that has stood the test of time in hundreds of plants, on many types of tool steels, under widely varying conditions.



From Tiny Taps To 50 lb. Hobs "Certain Curtain" Means Certain Success

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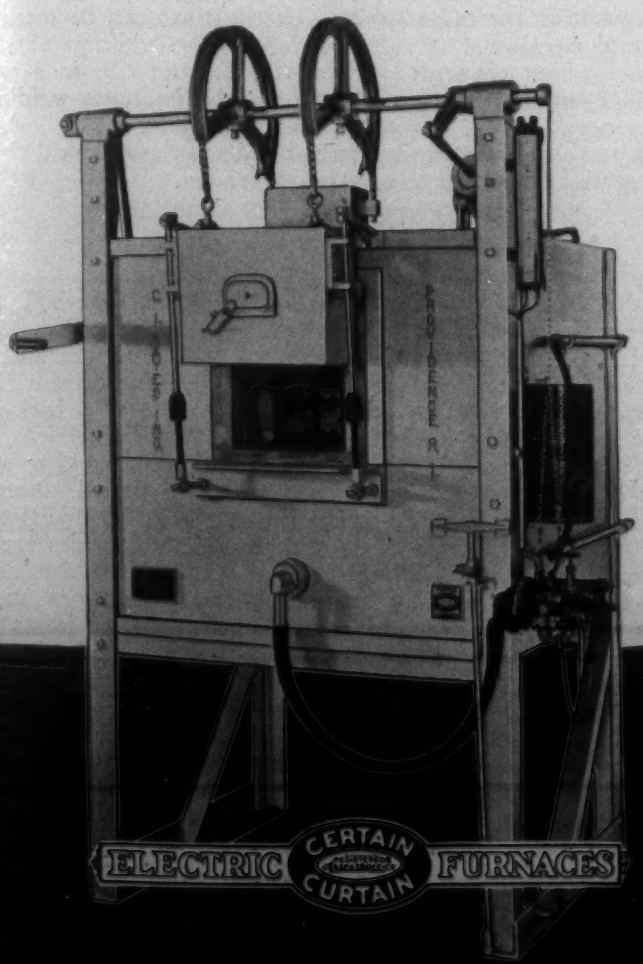
Famous makers of Custom Tools prefer it

Such well known tool firms as Cleveland Cutter and Reamer, Gorham Tool, Murchey Machine Tool, Michigan Tool, etc., find "Certain Curtain" invaluable because it protects them against spoilage and re-makes on special custom tools. In a month one firm hardened 2,000 hobs valued at $55.00 each without a single loss.

Users Report Amazing Savings

"Savings $521 per month" —— "Eliminated 11% spoilage on taps." —— "Saved cost of pair of furnaces in 5 months working 16 hrs. daily." —— "This daily $8 saving has paid for the furnaces in well under a year. Savings in the grinding room alone are $291 per month." —— "Savings far greater than anticipated."



Furnace shown at left is standard type HG for hardening high speed steels. Also made in vertical and extra large die sizes. Other "Certain Curtain" furnaces are for pre-heating high speed steel, hardening alloy, stainless and carbon steels, including standard, vertical, conveyor and special designs.

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6·WELDING AND CUTTING

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

Effect of Excess of Oxygen and Acetylene in the Welding Flame on the Mechanical Properties of Autogenous Seams (Einfluss des Sauerstoff-und Azetylenüberschusses in der Schweissflamme auf die Festigkeitseigenschaften von Autogennähten) H. HOLLER. *Autogene Metallbearbeit.*, Vol. 31, Oct. 1, 1938, pp. 313-316. Original research. With increasing ratio O_2:C_2H_2, the Brinell hardness decreases because of the increased O_2 absorption; the optimum of notch-toughness occurs at the ratio 1:1. Notch-toughness decreases with excess of either of the gases in the flame. The maximum tensile strength occurs between 1:1 and 1.1:1. Elongation and reduction of area also become very small with increased O_2 and C_2H_2 excess. Welding with excess of O_2 is not very difficult. Excess of C_2H_2 gives rise to difficulties; satisfactory joints can be made only up to a mixture of O_2:H_2C_2 of 0.9:1, a greater excess resulting in porous joints. Best nozzle shapes are briefly discussed. Ha (6)

6a. Ferrous

X-ray Study of Defects in Metal-arc-welded Parts of Mild Steel and their Effect on the Mechanical Properties. HARUMASA EKOGANEI & HAZIME NAKAMURA. *Trans. Soc. Mech. Eng., Japan,* Vol. 4, May 1938, pp. 172-177. In Japanese. English abstract p. S31. Original research. The general effects of defects (observed by X-ray photographs) on the physical properties are studied. The results are summarized as follows: *Deposited metal.* Specific gravity decreases as size and number of blow holes increases. Quantitative relation between them was not recognized. Electric resistance and permeability may have some bearing on the number of blow holes appearing in the X-radiograph, although this was not successfully proved. Tensile strength is always over 61,500 lbs./in.^{2} regardless of blow holes. Elongation and reduction of area vary markedly, depending on the amount of blow holes. Impact values vary according to number and distribution of blow holes as well as with microstructure. *Welded Part.* Electric resistance and permeability vary only slightly with the number of blow holes. Tensile strength does not vary, since the welded part is stronger than the parent metal. Free bending values vary according to the number of blow holes. If undercuts exist, a marked change takes place. However, the cast structure at the surface decreases the free-bending value. Thus a consideration of the microstructure is necessary. Impact value of the welded part varies according to number and distribution of blow holes and microstructure. The effects on fatigue limit of welded parts are still being studied. Results obtained so far show that the microstructure and distribution of blow holes has some effect on fatigue. EF (6a)

Flame-cutting of Cast Iron. C. H. S. TUPHOLME. *Foundry Trade J.*, Vol. 59, Sept. 15, 1938, pp. 203, 204. Practical. Cast Fe cutting requires a somewhat different technique from that used in cutting ordinary steel, although the equipment is substantially the same. The difference lies mainly in the manipulation of the blowpipe, the flame adjustment, and in the handling of the work in general. Those who already have oxy-acetylene cutting equipment, including a good general-duty cutting blowpipe and an O regulator of sufficient capacity for the pressure necessary, require no other special equipment for the average run of work. O supply, type of flame, O lance cutting, use of Al, etc., are discussed. If a tough adherent layer of slag forms on the metal in the kerf, and prevents further oxidation, the use of Al is recommended. Usually no more than 2 handfuls are necessary even for a large mass of Fe. Al acts as a flux to make the slag more fluid, and thus enables the cutting to continue. The oxidation of Al also supplies additional heat. Crushed Si or ferro-silicon may sometimes be used instead of Al as a fluxing material. AIK (6a)

Welding of Cast Iron (Beitrag zur Gusseisenschweissung) W. GEORGE. *Autogene Metallbearbeit.*, Vol. 31, Oct. 15, 1938, pp. 329-333. Five methods are discussed: Autogenous semi-hot welding, electric semi-hot welding, electric cold-welding, autogenous hot-welding, electric hot-welding. Semi-hot welding is called the welding without general preheating of the piece, and is used preferably for small pieces that heat sufficiently under the torch or electric arc. Electric cold-welding is advantageously used for repairing small defects in large pieces. A number of examples of all types are described. Ha (6a)

Strength Tests on Welded Corner Joints (Festigkeitsversuche an geschweissten Eckverbindungen) TASCHINGER. *Organ Fortschr. Eisenbahnw.*, Vol. 93, July 1, 1938, pp. 241-248. Original research. The object of the investigation was to study by tensile, compression and torsion tests the performance of welded corner joints made of rolled profiles and welded sheets. All samples were made from the German structural steel ST 37 (37 kg./cm.^{2} tensile strength). Welded sheets proved to be far superior to rolled profiles in tension. Cracks appear at considerably higher loads and at a safe distance from the welds. With rolled profiles, the cracks occur at relatively low loads in the welds in this static test. Under dynamic loads, this shortcoming will be much accentuated. In compression welded-sheets are also superior to rolled profiles, though less than in tension. No general conclusions from the torsional tests are warranted. The open profile samples are not suitable for this method of testing. Furthermore, there is no analogy between the clamping in the testing machine and actual service conditions. EF (6a)

Welding of Nickel-free Acid-resisting Steels (Das Schweissen der nickelfreien säurebeständigen Stähle) H. HOUGARDY. *Maschinenbau Betrieb,* Vol. 17, Aug. 1938, pp. 411-412. Practical. The ferritic acid-resisting steels, containing 16-18% Cr with or without Mo (1.8%) and widely used for chemical apparatus, show considerable grain growth and brittleness on heating above 1000° C. Grain growth depends not only upon the temperature itself but also upon the length of time during which heat is applied. Therefore, electric arc welding is better than autogenous welding for these steels. The ductility can be increased by annealing between 700° and 800° C. The addition of so-called carbide-forming elements, such as Ti, Ta and Cb, in a range of 0.5-2% hampers grain growth and thereby improves welding conditions considerably, and makes annealing unnecessary. As welding rod material, austenitic material of the same chemical characteristics as the ferritic matrix is recommended. RPS (6a)

6b. Non-Ferrous

Methods of Joining Copper Alloy Products, Part VII. Sheets. I. T. HOOK. *Metal Ind., N. Y.*, Vol. 36, Aug. 1938, pp. 382-384; Sept. 1938, pp. 427-429; Oct. 1938, pp. 472-474. Practical. Oxy-acetylene fusion welding of Cu, brass, "Everdur Silicon Bronze" and other alloys is often done without the use of a back-up bar. Corner welds can be made using a Cu or steel backer if it is protected with asbestos. $ZnCl_2$ flux is used for soft solder; resin or tallow are used where Cu or brass parts are tinned. Borax and boracic acid are used for brazing fluxes. NaCl is added to such fluxes for Cu welding; sodium and potassium fluorides are added for Ag soldering and welding Cu-Si alloys. Soft solders are used for metal-to-metal bonding as in electrical connections and as a sealing agent for riveted, lock-seamed or spot-welded joints. Pure grade Cu containing 0.05% Ag may be soft soldered without loss of its cold work strength and stiffness. Brazing and bronze welding are used when the strength of the joint is of paramount importance. Requirements in a Cu alloy weld are: (1) Strength, soundness and ductility; (2) comparable corrosion resistance, welded seam to sheet, and (3) color match. Welding technique for electrolytic Cu, tough pitch Cu, arsenical Cu, lake Cu, O_2-bearing Cu, electrical Cu, deoxidized Cu, commercial bronze, red brass 85, red brass 80, spring brass, yellow brass, Muntz metal, silicon red brass 1029, "Everdur Silicon Bronze," nickel silver, Ambrac, super nickel silver, phosphor bronzes, Ambraloy 901, and Be-Cu are discussed. For Part VI, see also *Metals and Alloys*, Vol. 9, Oct. 1938, p. MA 608R/6. CBJ (6b)

7·FINISHING

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

7a. Electrolytic Methods

The Adherence of Thick Silver Plate on Steel. F. C. MATHERS & L. I. GILBERTSON (Indiana Univ.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 30, 15 pp. Original research. The adherence and hardness of Ag deposits up to 0.05 in. thick were studied for the purpose of applying them to the production of bearings. The adherence of the deposit was determined qualitatively by noting whether the Ag separated from the steel when the specimen was bent back and forth until it broke. The thickness of the deposit affected the apparent adhesion of Ag, for some adherent thin coatings showed lower adhesion when their thickness was increased by further plating. Annealing of the deposits at 1000° F. for an hour increased the adhesion of the Ag. Brush plating gave a lower degree of adherence than the usual plating methods. The steel was prepared for plating by the usual cleaning procedures. followed by an acid dip consisting of 15 sec. immersion in 10% HCl, at 90° C. Better adherence was obtained on steel containing over 0.1% C, if an anodic treatment in 80% H_2SO_4 or a cathodic treatment in 10% HCl were used instead of the dip. The acid treatment was necessary for good adherence; it probably removed the oxide film and roughened the surface. Good adherence could not be obtained without a strike. Either a Cu or a Ag strike could be used. The cathode must be connected to the current before being immersed in the strike, and the current density used must be sufficient to produce vigorous gassing. The composition of the strike was not critical, but for any strike the current density and time must be so chosen that the specimen is completely covered with a Ag deposit that must not be spongy. A satisfactory strike is 1.9 g./l. AgCN, 17.9 g./l. KCN, 3.2 g./l. K_2CO_3, 6-20 amp./dm.^{2} c.d., time—1-5 sec. Instead of using a strike, the steel could be immersed in a 2% gelatin solution and then plated. The results compared favorably with those obtained with the Ag strike. The Ag plating bath had the following composition: 26.3 g./l. AgCN, 46 g./l. KCN, 37.5 g./l. K_2CO_3, 13 g./l. free cyanide. Current density was 0.4 amp./dm.^{2}. A bath in which the K_2CO_3 was replaced by $NaClO_4$ was tried, but it gave a bright, brittle deposit. AB (7a)

The Electrodeposition of Chromium from Trivalent Salt Solutions. W. H. WADE & L. F. YNTEMA (St. Louis Univ.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 26, 7 pp. Original research. Cr was electrodeposited from a bath 0.5 M. in chromium sulphate and 2-4 M. in ammonium sulphate. Operating conditions were: Current density, 12.5 amp./dm.^{2}; temperature, 35° C.; pH, 2. The current efficiency was 10-15%. The deposits were crystalline and inferior in quality to those obtained from the chromic acid bath. The addition of 0.1 mole./l. of citric acid or ammonium oxalate improved the deposit but considerably lowered the current efficiency. These compounds form complexes with the Cr salt from which chromic hydroxide does not precipitate until the pH exceeds 6. AB (7a)

Determination of Porosity and Mechanical Damage of Protective Coatings on Light Metals by Anodic Precipitation of Organic Dyes (Bestimmung von Poren und mechanischen Verletzungen in Schutzüberzugen auf Leichtmetallen durch anodische Abscheidung organischer Farbkorper) V. DUFFEK. *Z. Metallkunde*, Vol. 30, Aug. 1938, pp. 265-267. Experimental. The anodic precipitation of a dye was the most satisfactory method found for producing a rapid and permanent indication of coating imperfections. The test is successful with oxide, metallic and nonmetallic coatings on Al. An alkaline solution of alkali salts of azo or sulfonated aromatic dyes was most generally useful. GD (7a)

New Method of Plating on Aluminum. WILLIAM J. TRAVERS. *Metal Ind., N. Y.*, Vol. 36, Oct. 1938, pp. 475-477. Descriptive. The Al object is first given a high polish and degreased. It is then given an anodic coating, and immersed in a solution that has a solvent action on the film, for a pre-determined time. Ni is most satisfactory for an initial deposit; other metals may be plated on the Ni deposit. Bright Ni may be used if desired. CBJ (7a)

Technical Control of Electroplating Processes. S. C. TAORMINA. *Metal Ind., N. Y.*, Vol. 36, July 1938, pp. 336-338; Aug. 1938, pp. 374-376. Review. The effective control of electroplating processes begins with the design and layout of the plating room. The control factors discussed are: Power and its proper use; instruments for electrical control; number and size of plating tanks; solutions and proper standards; chemical analysis; equipment required and interpretation of results. Cathode efficiencies vary with current density; therefore, if a specified thickness of plate must be obtained, and the current densities are not high enough, the chances are that in most cases the cathode efficiencies are overestimated. Current for barrel plating is best estimated on the basis of pounds of material, as only a small part of the surface to be plated in a barrel is being plated at a given instant; the current density on that surface is very high. The size of the tank is determined by the shape and amount of work to be handled. A tank capacity of about 1 gal./amp. to be used has been found in practice to be adequate for most baths. Ni solutions are not critically affected by temperature; the most important factor is pH. In barrel plating, dragout is high and daily adjustments are usually required. Cyanide baths offer considerably more difficulty in their control. Cyanide Cu for striking is used hot at high current densities; small tanks are used, and it is important to check the free cyanide frequently. Metal and carbonates should be analyzed about once a week. Cold cyanide Cu plating baths have high cathode efficiency and the Cu content should be held high. Hot Cu cyanide plating baths require careful temperature control. The chief difficulty with acid Cu baths is the introduction of Fe in the bath, which causes rough, dark and hard-to-buff deposits. Streaky deposits are caused by operating these baths at 50° F. and lower. Ag solutions are most easily controlled. With sufficient anode surface, hardly any silver-cyanide additions are required. On the other hand, Ag strike baths require close control. Gold cyanide is not a very critical bath but because of its high cost should be rigidly controlled. RWB + CBJ (7a)

Specification Plating. Methods of Determining Quality. N. HALL. *Metal Ind., London*, Vol. 53, Aug. 19, 1938, pp. 183-185. Description of testing methods. Plating to specification was introduced by the automotive industry. Sales propaganda claiming 3 or 4 deposits often impresses the average buyer more than actual thickness figures, but this method of meeting plating to specifications only evades the issue, because it neither improves nor maintains quality of the finish. The old methods of determining thickness involved stripping the deposit. The most serious difficulty, the accurate measurement of the area of irregular objects, could not be overcome without the expenditure of considerable time and effort. Of the newer methods Mesle's Chord method of measuring thickness is probably the best suited for use in the average shop. The method is not as accurate as the microscopic but is sufficiently so for all practical operations where the thickness is about 0.0002 in. It involves grinding through the deposit, and from the width of the spot where the base metal is exposed, and the known radius of the curved surface or of the cutting wheel, the thickness can be calculated. For deposits of Cd and Zn, the Hull-Strausser dropping method is very suitable and has been widely adopted for this purpose. This method has been modified to use a jet in order to corrode the more resistant metals like Ni and Cu, and is called the B.N.F. Jet Test. Magnetic testing devices are available but require standardization. Generally the drop and chord tests are recommended for small plants. When plating is done to an intelligent specification, it will be raised from the present uneconomic plane to a technically high-grade industry. RWB (7a)

Technical Control of Electroplating Processes. S. C. TAORMINA. *Metal Ind., N. Y.*, Vol. 36, July 1938, pp. 336-338; Aug. 1938, pp. 374-376. Practical. Control factors in electroplating processes are: (1) Power and its proper use, (2) instruments for electrical control, (3) plating tanks, number and size, (4) solutions and the proper standards and (5) chemical analysis, equipment required and interpretation of results. General control measures for Cu cyanide baths, brass and bronze, Ni, Cd, Ag or Au solutions are discussed. CBJ (7a)

The Electrodeposition of Silver Alloys from Aqueous Solutions. FRANK C. MATHERS & AARON D. JOHNSON (Indiana Univ.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 27, 22 p. Original research. Binary Ag alloys containing Cu, Co, Ni, Zn, Cd, Fe or Pb were electrodeposited. Observations were made of the physical properties and the adherence of the deposits. Their resistance to tarnish was determined by immersion in H_2S water containing H_2O_2. Cu-Ag alloys containing 2-60% Cu were obtained from a bath consisting of Cu and Ag nitrates and 80 g./l. of thiourea. The deposits were smooth and soft, but only moderately adherent. Ni-Ag alloys containing up to 74% Ni were deposited from a bath containing Ag and Ni nitrates and 100 g./l. of NaCNS. Deposits that contained 5% Ni were smooth and hard, but not brittle. Ni-Ag alloys were also deposited from a bath consisting of Ag and Cu nitrates, 150 g./l. of $NaNO_3$ and 40 g./l. of tartaric acid. The maximum Ni in the deposit was 0.6%, and the deposit was hard and brittle. Fe-Ag alloys containing 1% or less of Fe were deposited from a bath consisting of the metal nitrates and 80-150 g./l. of NaCNS. These alloys were more resistant to tarnish and to acids than the other binary alloys produced. A thiosulphate bath was also used, but was found to be too difficult to control. Soft, ductile Cd-Ag alloys containing up to 30% Cd were obtained from a NaCNS bath. Deposits from a thiourea bath were gray and spongy. Smooth, adherent Zn-Ag alloys, containing a maximum of 3.8% Zn, were deposited from a bath consisting of Ag, Zn and NH_4 nitrates. A thiocyanate bath gave unsatisfactory deposits of a Co-Ag alloy, and the bath decomposed during operation. Co-Ag alloys, containing 0.5% Co, were deposited from a thiourea bath. The deposits were white, smooth and harder than Ag, but not brittle. Pb-Ag deposits plated from a fluosilicate bath were unsatisfactory. Good deposits were plated from an acid tartrate bath, but they contained a maximum of only 0.5% Pb. Best results were obtained with a bath consisting of potassium plumbite and $KAg(CN)_2$. The deposits contained up to 70% Pb and were softer than Ag plated from a cyanide bath. The Co-Ag and Pb-Ag alloys tarnished more readily than pure Ag. AB (7a)

Electrolytic Deposition of Indium and Silver-indium Alloys (Die galvanische Abscheidung von Indium und Silber-Indium-Legierungen) E. RAUB. *Mitt. Forsch. Inst. Probieramt Edelmetalle, Schwäb. Gmünd*, Vol. 12, Sept. 1938, pp. 55-59. Original research. (For previous work, see *Metals and Alloys*, Vol. 8, Nov. 1937, p. MA 692R/6). The purpose of the investigation was to determine whether In-plating can prevent tarnishing of Ag, which alloying of In with Ag fails to do. Plating with In and Ag-In does not produce tarnish-proof layers; the deposits from cyanide, cyanide-free, chloride and sulphate solutions are sometimes very dull, and no really bright deposits could be obtained; polishing removes too much metal, or In is very soft. A superficial Ag-In alloy was obtained by diffusion in H of In-coated Ag sheets; this layer was hard and tarnish-proof; it was dull, however, even in the polished condition and cannot be used for practical applications. Ha (7a)

Bright Nickel Plating. *Steel*, Vol. 103, Aug. 29, 1938, pp. 50-52. Industrial note on process developed by Seymour Mfg. Co., Seymour, Conn., and its application to manufacture of flat-irons. Uses purified and filtered standard Watt's bath containing certain addition agents [composition not stated]. Advantages claimed: Production of soft, ductile, brilliant Ni plate; freedom from pitting; ease of operation; good throwing power; bright plate at all thicknesses; and ability to Cr plate without activation or color buffing. Chief advantage is elimination of finishing operations before Cr plating. Base metal, which may be ferrous or non-ferrous, must have a suitable high finish to be bright Ni-plated directly by the process. Before adding ingredients for process, Cu, Fe, etc. are removed from Watt's solution. It is then heated to at least 150° F. and enough lime (at least 5 lbs./100 gal. solution) is added to bring pH above 6.5 quinhydrone. After 1 hr. at 150° F., 32 oz. of 100-volume H_2O_2 is added per 100 gal. bath and stirred. After settling over night, solution is filtered into plating tank. Temperature is adjusted to 110° F. and pH to 2.8 quinhydrone. Adjustment of latter is made with H_2SO_4 or $NiCO_3$. MS (7a)

"TRENDS" . . .

a new department on page MA70, interprets today's news in the light of probable future developments. This will be a regular monthly feature. You will want to read it.

Radiator Grilles. *Steel*, Vol. 103, Sept. 12, 1938, pp. 58-60. Description of commercial installation for automatic Cr-plating at Cadillac Motor Car Div., General Motors Corp. All parts, regardless of size or shape, are routed through the same Cr-plating equipment, using a constant current-density. Parts, after polishing, buffing and degreasing, are Cu-plated in a Cu $(CN)_2$ solution of so-called low-Rochelle type, containing 2 oz. salts per gal. Positive contact between racks and bus bar running along side of tank is insured by playing H_2O stream continually on bus at the spot where rack first makes contact. Parts are then washed and bright Ni-plated. Both Cu and Ni solutions are continually filtered and passed through heat exchangers to maintain proper temperature. An important factor in efficient operation of Cu and Cr tanks is careful balancing of loads. Special types of racks were constructed for Cr-plating. Brass wire "antenna" around the outside of rack is connected to cathode side to pick up excess current and prevent burning of outside pieces. Auxiliary Ni anodes near the center of each rack are energized by a bipolar generator operated with plating machine, and give off enough additional current to balance rate of deposition at center with rate at outside. Parts are cleaned electrolytically, rinsed, dipped in 5% H_2SO_4, rinsed, and Cr plated in CrO_3. Temperature of bath is held at 120° F. ±2° by a controlling pyrometer which pumps solution through either a heat exchanger or H_2O cooler. A generator supplies 3,000 amps. at 14 volts to the work the moment it enters tank, and continuing for 20 sec. Then, by means of breakers in anode and cathode rails, a second generator is cut in to supply 6,000 amps. at 5 volts. Auxiliary anodes are supplied with 3,000 amps. at 6.5 volts. Initial high voltage and lower current produce an instantaneous Cr layer over all exposed surfaces. Then, by easing off voltage and stepping up current, the deposit is built up gradually to required thickness. Dragout is reclaimed by dipping work in an adjoining tank, resulting in considerable saving of CrO_3. Plated parts are given several rinses. At usual production speed, circuit through the machine requires 18 min. MS (7a)

Corrosion of Silver Anodes in Potassium Silver Cyanide Plating Solution. A. E. THURBER, DANIEL GRAY & R. H. SHOLTZ (Oneida Ltd. Labs.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 20, 15 pp. Original research. Good Ag anodes should corrode evenly down to thin scrap and should not produce loose particles or sludge that may cause rough deposits. The Ag anodes used in the investigation were in most cases over 99.95% pure Ag, the impurities being mainly Cu, Fe, Pb, Mn and Bi. Pb and Bi in anodes cause uneven corrosion and form a sludge. Small quantities of Cu (a few hundredths %) and Mn (about 0.001%) are not harmful. Anodes having a fine grain size corrode more smoothly than others. The black sludge from some anodes was analyzed and found to contain C and other organic material, Pb, Fe, Bi, Mn and sometimes Sb. AB (7a)

7b. Non-Electrolytic Methods

Brass Spraying with an Electrically Operated Spray-Gun. Y. HOSINO & T. TAKEI. *Nippon Kinzoku Gakukai-Si*, Vol. 2, July 1938, pp. 318-324. In Japanese. Original research. Cu content of the coating increases with increasing arc-voltage and air blast pressure; microstructure of the coating shows oxides, eutectics, etc. The coefficient of thermal expansion of the sprayed brass between 20° and 70° C. was nearly 10% smaller, apparent specific gravity was also about 15% smaller, but the electric resistance was about 3 times greater than the corresponding properties of ordinary brass of the same composition. Hardness depended noticeably upon the air blast pressure; tensile strength, elongation and impact value of the coating were small. The adhesive strength of the coating sprayed on soft steel depended considerably on the initial surface condition of the steel. NS (7b)

Production Methods for Composite Steels. *Iron Age*, Vol. 142, Aug. 4, 1938, pp. 33, 39. Practical. Considerable advance has been made in the making of composite steel stock especially in the elimination of oxidation, as is successfully done by the Armstrong process. Corrosion and heat-resisting clad plates are first electrolytically pickled to remove oxide. While still wet, Fe is electrodeposited to a thickness of 0.015 in. on the surface to be clad with the special steel. Previous to rolling, component layers are joined by fusion welding to exclude furnace gases from areas to be welded. In casting, the Armstrong method has also been used to advantage. VSP (7b)

The Fight Against Silicosis in the Metal Industry (Die Bekämpfung der Staublungenerkrankung in der Metallindustrie) *Oberflächentech.*, Vol. 15, Sept. 20, 1938, pp. 180-181. Review. Silicosis develops in men working in sandblasting or grinding of metals more rapidly than in miners. Means for preventing the inhaling of the fine metal dust, adequate equipment, and clinical aspects are briefly discussed. Grinding wheels of artificial stone are much more sanitary, as the dust contains no free SiO_2, which is the main cause of silicosis. Wherever possible, artificial stones should be used. Ha (7b)

Announcing

SAMPLING AND ANALYSIS OF CARBON AND ALLOY STEELS

Prepared by the Chemists' Committee of The Subsidiaries of the U. S. Steel Corporation

EXACT CHEMICAL SPECIFICATIONS govern the manufacture and purchase of steel products. To insure compliance with these specifications, standardized and minutely accurate analytical procedures are essential. The necessity for standardization of methods becomes evident when it is realized that corrosion and heat resistance and other specific properties, are obtained by the addition to steel of such elements as nickel, chromium, molybdenum, etc., sometimes in almost microscopic percentages. When determinations accurate to the third decimal place are demanded, no tolerance can be allowed for the slightest variation in procedure.

AUTHORITATIVE AND DETAILED PROCEDURES are simply and lucidly presented in this volume. Its aim is to enable any chemist to analyze steels with meticulous accuracy, and it accomplishes this aim by eliminating as far as possible the "human equation." Careful observance of the directions and cautions given will not only reduce the time of determination to a minimum, but will yield absolutely reliable results. This will be of tremendous value to the relatively inexperienced chemist who may have occasion to make check analyses of steel shipments. Since large-scale production of alloy steels is a comparatively recent development, the need for authoritative methods is greater now than ever before, and will be constantly increasing. Everyone interested in testing and analytical work should possess this volume.

SUBSIDIARIES OF THE U. S. STEEL CORPORATION have developed many new methods over a period of years. Their book, 356 pages in length, comprises the most complete and modern body of information on steel analysis that has ever appeared. This corporation has long been prominent in making available to industry everywhere information dealing with sampling and testing of materials used and produced in the iron and steel industry. Eight volumes, totalling 17 editions, published directly by the U. S. Steel Corporation at intervals during the last 30 years, have met an enthusiastic reception the world over, not only within the industry but in scientific libraries and universities. The Reinhold Publishing Corporation has been entrusted with the publication and sale of this latest volume.

THE SCOPE OF THIS BOOK *includes approved procedures for sampling mill products, and for determining all the elements that may occur in steel under any conditions of combination. Methods are given for such infrequently* occurring elements as beryllium and cerium. The first appendix article describes three recent new procedures for determination of sulfur by combustion, most desirable when it is impossible to obtain the sulfur content by older methods. The skeleton table of contents below gives a general summary of the subjects covered.

Because of the extent of the full Table of Contents, only Chapter Headings are given.

Sampling.
Qualitative and Quick Tests for Identifying Various Types of Steel.
Methods of Analysis.
Chemical Separations.
Determination of Manganese.
" " Phosphorus.
" " Sulphur.
" " Silicon.
" " Copper.
" " Nickel.
Determination of Chromium.
Determination of Vanadium.
" " Molybdenum.
" " Titanium.
" " Aluminum.
" " Arsenic.
" " Tin.
" " Cobalt.
" " Tungsten.
" " Uranium.
" " Zirconium.
Determination of Columbium and Tantalum.
Determination of Selenium.
" " Boron.
" " Beryllium.
" " Nitrogen.
" " Antimony,
Copper and Molybdenum.
" " Zinc.
" " Cerium.
Appendix I: Determination of Sulphur or Carbon and Sulphur by Combustion in Oxygen.
Appendix II: Discussion of Methods for Oxygen, or Oxygen, Hydrogen and Nitrogen in Steel.
Appendix III: Preparation, pH Ranges, and Color Changes of Various Organic Chemical Indicators.
Appendix IV: Table of Atomic Weights, Atomic Numbers and Other Physical Constants of the Elements.

356 Pages **33 Chapters** **Apparatus Diagrams** **$4.50**

REINHOLD PUBLISHING CORP., 330 W. 42nd Street, New York, U. S. A.

Metallic Protective Coatings on Aluminum Alloys. *Light Metals,* Vol. 1, Sept. 1938, p. 283. Review. One of the earliest duplex metal products was Ag on Cu, produced by casting the cladding metal (Ag) around a core of Cu as a basis metal. Al cladding has been in use only for about 15 years. Two early methods of cladding Al alloys with corrosion resistant pure Al were: (1) Casting high-purity Al around the Al alloy, and (2) hot rolling or pressing the 2 materials together. A thin cladding of pure Al is desirable on account of the lower strength of pure Al, but the coat cannot be too thin or its protective value will be reduced. One proposed method for using inferior or secondary Al sheet for cooking utensils, a field in which costs must be kept low, is to weld several sheets together in the expectation that impurities will not form a continuous and inter-connecting path from one side to the other. If a heavy metal is used as a cladding material on Al, different techniques are possible, since the heavy metal usually has a higher melting point than Al. Superheating of the heavy metal above the melting point of the Al, followed by placing the 2 pieces in contact, is sometimes sufficient to melt the Al without heating it directly. The Al is melted only near the surface of contact, and since the body of the Al remains relatively cool, the 2 may be rolled together without too much deformation of the Al. Certain elements, particularly Cu, should not be permitted to diffuse into a clad coating of Al as the corrosion resistance is thereby lowered. A third metal, sandwiched in between the basis metal and the cladding, has been recommended for this purpose. An oxide film on the basis metal prior to the cladding has been suggested, but no details are available. In Germany a process has been developed in which an Al alloy containing Mn and Mg (which are not detrimental to corrosion resistance) is sandwiched in between the basis metal, containing Cu, and the pure Al coating. The Cu diffuses from the basis metal to the intermediate layer, but not to the outside layer. Hard-facing of light alloys is necessary, for example, in sludge scrapers or in implements subject to heavy abrasion. In one device of this kind developed by Schlüpmann, the hard metal is melted on a sump or refractory dish on one edge of the Al alloy plate to be hard faced. A gas torch is used to melt the hard-facing alloy which, after melting, runs onto the surface of the work. AUS (7b)

Care of Hot and Solvent Vapor Degreasers. E. V. D. WALLACE (Mechanical Process Corp.) *Metal Cleaning Finishing,* Vol. 10, Sept. 1938, pp. 634-638. Discussion. Care should be taken to prevent fumes from entering the work room. The machine should be protected from drafts and if necessary provided with a draft guard and ventilating system. It should not be located near heat-treating furnaces or welding machines because escaping vapor is decomposed by heat with the production of obnoxious fumes. Loss of solvent can be minimized by not cleaning too large a load of parts at a time since this results in the displacement of a large volume of air saturated with solvent, and by letting bulky parts or baskets of small parts hang above the tank for 30 sec. before removal, so that the solvent can drain back into the tank, either as vapor or liquid. The degreaser should be cleaned every 2 weeks and the solvent should be neutralized with alkali and distilled. Al dust from the cleaning of Al parts should be removed as it may react with the solvent. Deposits of dirt should be removed from the heating units. AB (7b)

"Superfinished" Surfaces. A. F. DENHAM. *Am. Machinist,* Vol. 82, July 27, 1938, pp. 678-680; Aug. 10, 1938, pp. 722-725; *Machinery, N. Y.,* Vol. 44, Aug. 1938, pp. 858-864. Original research. "Superfinish" is a term connoting an extremely fine surface finish produced on any kind of surface by a combination of short motions, light abrasive pressures, slow abrasive cutting speeds, hard abrasive stones and a lubricant of proper viscosity. The process is said to eliminate all scratches and surface defects left by previous operations without creating new scratches. The mechanism of the process, as it differs from ordinary polishing methods, is explained. Numerous applications are described. Ha (7b)

Preparation of the Surface of Steelwork Prior to Painting. *Iron Steel Inst., Fifth Report Corrosion Committee,* 1938, pp. 351-368. Discussion and research. Methods of removing scale are discussed. Various phosphate treatments for use prior to painting are mentioned. Some experiments on scale removal with wire brushes are described. Although mill scale can be completely removed with brushes, the method does not seem to be entirely practicable. Plans for investigating the effects of different pickling methods on paint life are described. JLG (7b)

Descaling and Derusting by Sandblasting (Das Entzundern und Entrosten mit dem Sandstrahlgebläse) *Oberflächentech.,* Vol. 15, Sept. 20, 1938, pp. 181-182. Cleaning of metal surfaces from rust and scale before putting on a protective coating is done most satisfactorily by sandblasting. Installation must be selected according to purpose. Sharp quartz sand of 1-1.5 mm. grainsize is most advantageously employed under a pressure of 1-2 atm., the energy required amounts to 2.5-7 HP and 3-12 m.³ air/min., according to capacity. Examples are described. Ha (7b)

Spent Pickle Liquor. *Steel,* Vol. 103, July 25, 1938, pp. 35-36, 61. Industrial note on new process for treatment of spent pickle liquor. This is collected in a storage reservoir, from which it is pumped into 2 or more precipitating tanks. Each batch, as treated, is neutralized with Ca or Mg alkalies, such as dolomitic or ordinary limestone, at 150° F. Batches remain in tanks for about 1 hr. Precipitate, consisting of Fe $(OH)_3$ and $CaSO_4$, is removed in filter-presses, charged into a pug-mill, de-aired, oven-dried at 175° F. and cut to form or ground up. For certain applications, fiber is introduced into batches in the precipitating tanks. Effluent from filter-presses is clear, uncontaminated H_2O, which can be discharged into sewers or streams, or can be used in plant operations. Precipitate, designated "Ferron," makes an excellent insulating material, which is fire-proof and termite proof, will not warp, and can be easily cut, sawed and machined. It is homogeneous and solid appearing, but extremely porous. It removes H_2S and other S compounds from gases and liquids, and provides a good filtering mass for many operations. A plant having a capacity to transform 10,000 gal. of spent pickle liquor per day into 25 tons of insulation costs about $50,000. MS (7b)

Mirrors of Motordom. A. H. ALLEN (Staff) *Steel,* Vol. 103, Aug. 1, 1938, pp. 23-24. Review. To enhance wearing qualities of engine parts subject to wear, they are being subjected to treatment similar to the so-called rustproofing process applied to body sheets before painting. One large company is substituting the Granodizing process for present Cu plating used on camshafts. It is claimed that the thin phosphate coating deposited on the part provides a semiporous surface for holding lubricant, thus increasing wear resistance. Present plating tanks will be used, with electrical system removed except for cleaning. For reducing wear to a minimum, Chrysler is finishing certain parts with a special type of machine equipped with abrasive tools (350-500 grit) and combining short oscillating motion with light abrasive pressure and a lubricant of proper viscosity. Surface of exceptional smoothness is claimed to result. Ford has overcome wear on cylinder walls at point where tops of pistons are at upper limit of stroke, by inserting narrow liners of 3.5% Ni iron. MS (7b)

The Conception, Development, Equipment and Measuring Methods for an Entirely New Surface Finish Method—Superfinish. WILLIAM F. SHERMAN (Staff) *Iron Age,* Vol. 142, Sept. 1, 1938, pp. 18-23; Sept. 8, 1938, pp. 40-45; Sept. 22, 1938, pp. 57-61, 90. Practical description of a new surface finish produced upon flat, internal, external, round and other types of surfaces by a combination of short motions, light abrasive pressures, slow abrasive cutting speeds, hard abrasive stones and a lubricant of proper viscosity that eliminates scratches and surface defects created by previous mechanical operations, without creating scratches or defects. Presents also new conceptions, definitions of terms used, and compares the use of this technique with conventional methods of finishing automotive parts. Finally deals with measurement of temperatures on metal surfaces, hardness ductility, strength of oil films and other lubricant specifications which must be taken into account with this process. VSP (7b)

The Metalastik System of Bonding Rubber and Metal. *Engineering,* Vol. 146, Sept. 30, 1938, p. 391. Practical discussion. Detailed description of the process is not available. It consists, in general, in plating of metal parts, by electrodeposition, with a film of an alloy having the appearance of light colored brass. The surface is perfectly smooth, yet is of such structure that the rubber, when vulcanized, may be said to fuse homogeneously with it. Results of tests conducted on the product are given. It is used for damping torsional oscillations and vibration in continuously moving machinery, and was developed by Metalastik, Ltd., Lancaster, Eng. VSP (7b)

Plastic Coatings Applied to Pipes Automatically by New Process. J. EDW. TUFFT. *Steel,* Vol. 103, July 11, 1938, p. 58. Describes automatic, gas-engine driven machine for placing concrete coating on pipe-lines to reinforce pipe and to protect it against corrosion, invented by Thomas H. Wilson. Coating is applied in trench, without disturbing pipe-lines, by a rubbing pressure without use of supports or forms of any kind. Normal speed under average conditions is 200-300 ft./hr. for 6-in. pipe, and 24-60 ft./hr. for 24-in. pipe. Thick coatings, ¾ in. on 3 in. pipe up to 2 in. on 18-in. pipe, are recommended. MS (7b)

Bars and Shapes Tumbled Free of Rust and Scale. *Iron Age,* Vol. 142, July 14, 1938, pp. 33-34. Practical description of a patented machine and process for cleaning rust and scale from steel bars, shapes and pipe rapidly at a cost of about $1 per ton. On some types of material it is as efficient as pickling or sand blasting. This process is said to leave the steel so clean that it can be cold drawn, machined, welded, galvanized, etc., without further cleaning. Fine coke or blast furnace slag free from Fe is used both as an abrasive and a cushion for the material. Developed by J. M. Hebbish and J. K. McCahan. VSP (7b)

8·TESTING AND CONTROL

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

Standardization of the Notch Impact Test (Beitrag zur Normung der Kerbschlagprobe) V. JARESZ. *Czechoslovakische Normungsgesellschaft & Czechoslovakischen Verband für Materialprüfung,* Prague, 1937, 55 pp. Review. The various types of steels tested and the various types of notch impact samples common in different countries are discussed. The V-notch permits better judgment of the notch sensitivity of steel than the round. The type of V-notch is not so critical; the English standard notch is preferred. The decision as to the best round notch is difficult; the 5 mm. round notch, although standardized in France, is disadvantageous as the cross-section is too small and the gradation of different steels is poor. Of the other types of notches, Mesnager 2 mm. deep and Moser 3 mm. deep, the latter proves better for plain C steels. For heat-treated alloyed steels both types of notches are equally suitable. International standardization of the French standard specimen is the least advisable. These as well as earlier Italian investigations by Steccanella (*Met. Ital.,* Vol. 24, 1932, No. 5, and Teoderesco, *Metals and Alloys,* Vol. 4, Aug. 1933, p. MA 249) proved a considerable fluctuation of the notch toughness ratio of the Mesnager and Moser specimens. Therefore, there is no general possibility of transforming Mesnager into Moser data. To a certain extent, however, this is possible with good normal steel quality. GN (T-8)

Non-destructive Testing by Gamma Rays. J. G. HALL. *Foundry Trade J.,* Vol. 59, Sept. 1, 1938, pp. 157-158. Review Differences between X-rays and γ-rays, apparatus and methods, influence of distance, density considerations, time-temperature method, etc. are discussed. γ-rays are produced in the disintegration of Ra. Whereas the limit for the practical use of X-rays for testing purposes is in the region of 4 in. of steel, γ-rays have been found effective up to 10 in., with a possible extension to 12 in. A capsule of less than ¼ in. diameter contains enough radio-active substance for the examination of any commercial object. The apparatus and methods for γ-radiography are very simple. A small container of radio-active material, radium sulphate sealed in small Ag capsules, is supported rigidly in front of the object to be inspected, and X-ray films in light-tight holders are fastened to the back of the object. Ra emits α, β and γ rays, all of which are inimical to the health of the workers. Ra should be stored in a safe of solid Pb of some 6 in. thickness in all directions, should be handled with tongs or strings, never touched directly with the hands, and should not be approached nearer than a distance of 10 ft. unless shielded by heavy castings. AIK (T-8)

The Effect of Sample Size and of the Dependence of Excitation of the Line Intensity on the Mean Error in Spectral Analysis (Der Einfluss der Probengrösse und der Anregungsabhängigkeit der Linienintensität auf den mittleren Fehler bei der Spektralanalyse) G. THANHEISER & J. HEYES. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 13, 1938, pp. 153-166. Research. The effects of electrode diameter and of the selected pairs of lines upon the average variations in spectrum analysis were investigated on a steel of 0.23% C, 0.23% Si, 0.50% Mn, 0.010% P, 0.028% S, 2.75% Ni and 0.68% Cr. The electrodes were of 1-36 mm. diam. The least variations of intensity were found in electrodes of 3-5 mm., the best obtainable variations were about 3%. 13 references. Ha (H-8)

Comparisons of Non-destructive Testing by X-ray Shadow Pictures and by Magnetic Inspection (Vergleichende Betrachtungen der zerstörungsfreien Werkstoffprüfung durch Röntgenschattenbild und durch magnetische Prüfung) M. V. SCHWARZ. *Berg- u. Hüttenmänn. Monatsh. Montan. Hochschule Leoben,* Vol. 86, July 1938, pp. 189-193. **X-ray and Magnetic Tests of Welds (Röntgen- und Magnetprüfungen von Schweissungen)** R. BERTHOLD. *Ibid.,* pp. 193-195. Review. Both methods are critically discussed, and a great many examples are reproduced photographically. The magnetic method is considered superior to the X-ray method in testing a material for cracks (particularly very fine ones) as they can more readily be detected by the deviation of the magnetic lines of force. Apparatus is described. Ha (T-8)

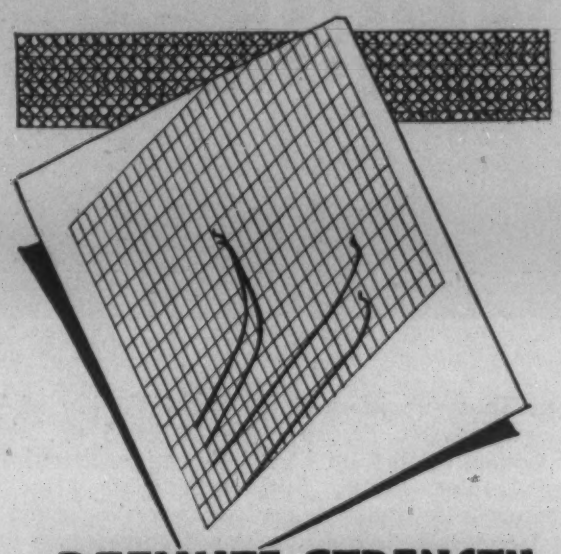
Proposed Tentative Method for Bend Testing of Wire. *Am. Soc. Testing Materials,* Preprint, June 1938, 5 pp. Appendix to Report of Committee B-4 on Electrical-heating, Electrical-resistance and Electric-furnace Alloys. Specifications are given for a test intended to evaluate the "temper" of wire for radio tubes, incandescent lamps and electrical resistance purposes, in terms of the energy expended in producing a given amount of bending. It is intended for use on wire from approximately 0.010 in. to 0.117 in. diameter. The test comprises clamping a specimen of wire rigidly at one end, subjecting it to a bending force and measuring the energy absorbed by the specimen per unit of bending. The bending force is applied by means of a loading system such as a pivoted, weighted arm actuated by gravity and carrying a "bending die" which maintains contact with the specimen during the bending operation. Thus, the energy absorbed by the specimen may be calculated from a knowledge of the magnitude and location of the unbalanced weights and the angle through which the moving elements turns from a predetermined initial position until brought to rest by the resistance of the specimen. VVK (T-8)

Secondary Radiation in the Radiography of Aluminum, Steel and Lead. HERMAN E. SEEMANN (Kodak Res. Labs.) *Am. Soc. Testing Materials.* Abstract Preprint, June 1938. Comparatively simple tests indicate that secondary radiation interferes seriously with the observation of detail in a radiograph. Curves show that, for a given density, there is a progressive decrease in contrast with increase in proportion of diffuse secondary radiation. In the experiments reported, exposures were made with and without Pb foil intensifying screens to see how effective these screens are in removing secondary radiation. The results indicate that there is almost a linear increase in proportion of secondary radiation with increase in thickness of the material. Pb foil screens may remove almost ½ of the secondary radiation. Hence, their use is advantageous but still leaves something to be desired. Some difference in the amount of secondary radiation would be expected at different kilovoltages but none has been detected. This may be partially due to compensating effects but the kilovoltage range that can be used advantageously for a given specimen in practice is so small that the difference is probably negligible. VVK (T-8)

Spectrographic Analysis at a Large Technical Laboratory. ABRAHAM MANKOWICH. *Metals and Alloys,* Vol. 9, June 1938, pp. 131-137. Descriptive. Considerable time in analysis is saved on the determination of minute impurities in metals and many chemical compounds by analyzing the spectrographic results of vaporizing a small volume of solution of the unknown in a direct current arc. The size of the liquid sample is dependent upon the concentration of the substance being analyzed and also upon the substance itself. The unknown spectrum should be compared with that of a standard solution for match. The density of the impurity lines in the unknown and standards should be compared using a densitometer. For certain determinations, such as Ca and Na in $BaNo_3$, the C arc was found to be unsatisfactory; therefore, a Cu electrode was used in place of the graphite. Details of application of spectrographic procedure to the analysis of a wide variety of commercial metals and alloys are given. WLC (H-8)

Determination of Boron in Steel and Cast Iron. JOHN L. HAGUE & HARRY A. BRIGHT. *J. Research Natl. Bur. Standards,* Vol. 21, Aug. 1938, pp. 125-131. Original research and development. A method is described for the determination of small amounts of B in steels and irons. The procedure calls for (1) solution of the sample in HCl followed by oxidation in H_2O_2, (2) distillation of methyl borate (Chapin's method), and (3) titration of B $(OH)_3$ with NaOH in the presence of mannite. Se and Te do not interfere, but Ge, a very minor constituent rarely present in ferrous metals, causes small positive errors. Method accurate to ± 0.002% for alloys containing from 0.005 to 0.1% B. WAT (T-8)

Spectrographic Examination of Assay Beads for Platinum, Palladium and Gold. J. SEATH & F. E. BEAMISH (Univ. Toronto) *Ind. Eng. Chem.,* Anal. Ed., Vol. 10, Sept. 1938, pp. 535-537. Original research. The authors suggest the preparation of duplicate assay beads for preliminary spectrographic examination which may effect a time-saving in the wet analysis for the precious metals. If Pd, Pt and Au lines are absent in the bead spectrum, the separation procedure may be omitted. Details are given. MEH (H-8)



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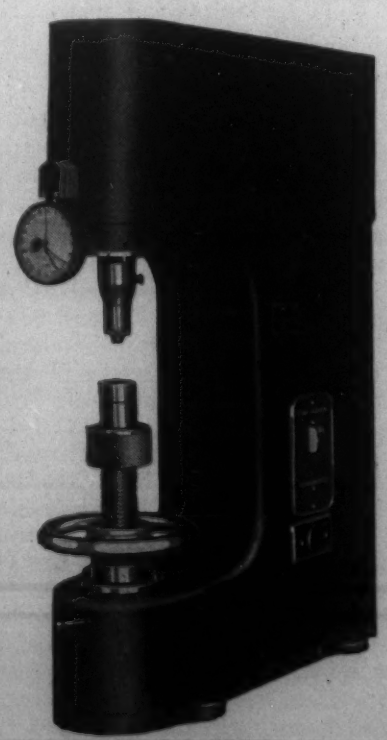

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Elimination of Scrap in Drawing Hollow Bodies of Thin Sheets, with Special Reference to Available Deep Drawing Testing Methods (Die Beseitigung des Ausschusses beim Ziehen von Hohlkörpern aus dünnen Blechen unter besonderer Berücksichtigung der bisher bekannten Tiefzieh-Prüfverfahren) GERHARD OEHLER. *Beiträge zur Wirtschaft, Wissenschaft u. Technik d. Metalle u. ihrer Legierungen,* No. 5, 1938, pp. 1-87. After giving a detailed account of the various factors playing a role in deep drawing processes, such as lubrication, drawing power, holding pressure, fillet at the drawing edge, drawing gap, drawing speed and graduation of draws, the author describes his own experiments in deep drawing 7 different types of sheets: Brass sheet, Al sheet, tin-plate and 4 different types of common deep drawing Fe sheets, and compares the practical results with the quality standards established by the various methods of testing deep drawability. A most comprehensive critical review of the testing methods is given. With the cupping methods (Erichsen, Olsen, Guillery, Amsler, Avery, etc.) the minimum size of the sample should be 3 times the drawing edge diameter, *i.e.* for the Erichsen method with 27 mm. interior drawing edge diameter, a square sample of 90 mm. side length should be applied. Otherwise too large deep drawing values result. The type of lubricant has considerable effect on the result. With vaseline and tallow higher values result than with common machine grease lubrication. The mathematical evaluation of the AEG testing method according to Schmidt (*See Arch. Eisenhüttenw.,* 1929, No. 3, p. 213) was critically investigated. The assumption that the punch pressure increases with the diameter ratio β of blank diameter to drawing diameter holds true for brass and Al sheet, but only approximately true for Fe sheet. By determining the β values of different sheet types and sheet thicknesses, quality standards of deep drawing sheets can be established. Furthermore, the graduation of the tools can be determined. Vice versa, with given tools, the sheet quality required to attain the desired β values can be established. The change of the β value conforms to the longitudinal elongation and the circular elongation increase, but not in regard to size. The longitudinal and the circular elongation, as determined by the Siebel-Pomp widening method, give similar values. The grain can be studied better by the Siebel-Pomp method than by the common cupping methods. The practical drawing tests were in best agreement with the elongation measurements in tensile tests; drawing tests according to the AEG method gave results in accordance with the results of the Schmidt and of the Siebel-Pomp widening tests. The common cupping tests and bending tests range second in conformity with the practical results. The folding test and hardness measurements permit no judgment of deep drawing properties. Neither decrease nor increase in sheet thickness, nor the deviation of the actual drawing depth from the depth calculated permit accurate conclusions as to the deep drawability of a sheet. The practical tests show different behavior of the various drawing shapes with the various materials. It could not be proven that certain sheet testing methods are better fitted for certain drawing shapes than others. GN (T-8)

Spectrographic Analysis of Steel by the Solution Method and its Application to the Investigation of Dendritic Structure in Steel Ingots. Y. KANAMORI. *Nippon Kinzoka Gakukai-Si,* Vol. 2, Aug. 1938, pp. 413-418. In Japanese. Original research. A new solution method was studied so that analysis could be made even when sample is small in quantity or relatively high in alloying elements. A sample of 0.2 g. of Fe is dissolved in 5 cc. of HCl solution and compared spectrographically with standard solutions of the same concentration. The quantity of the element determined was varied in the range of 0.04-0.6 mg./cc. Anaylses for dendritic segregation in Ni-Cr and Ni-Cr-Mo steel ingots showed that Ni, Cr and Mo are richer in the fillings of dendrites than in the branches. NS (H-8)

The Relation between the X-radiograph of a Weld and Its Tensile Strength (Der Zusammenhang Zwischen dem Röntgenbild einer Schweissnaht und ihrer Zugfestigkeit) E. A. W. MÜLLER. *Arch. Eisenhüttenw.,* Vol. 12, July 1938, pp. 25-26. Original research. Electric-arc V and X welds in structural steel plates 10-16 mm. thick were made, the welded seams X-rayed, and tensile tests made. The effect of various types of defects in lowering the tensile strength is shown by radiographs and accompanying values of tensile strength. The effects of smaller pores and inclusions were unnoticeable; the main causes in lowering the tensile strength were discontinuities in the welds, absence of proper beads, and large pores. SE (T-8)

A Level-bubble Strain Gage. REX L. BROWN (Univ. Illinois) *Am. Soc. Testing Materials,* Preprint, June 1938, 2 pp. This paper describes a strain gage that has a sensitivity to seven millionths of an in. A 5-sec. level bubble is used as a measuring device. It is fastened to the moving leg of the instrument, and its level changes with strain along its gage length. The instrument is adapted for use along horizontal gage lines, and has been used to measure very small strains in the concrete of reinforced-concrete slabs. VVK (T-8)

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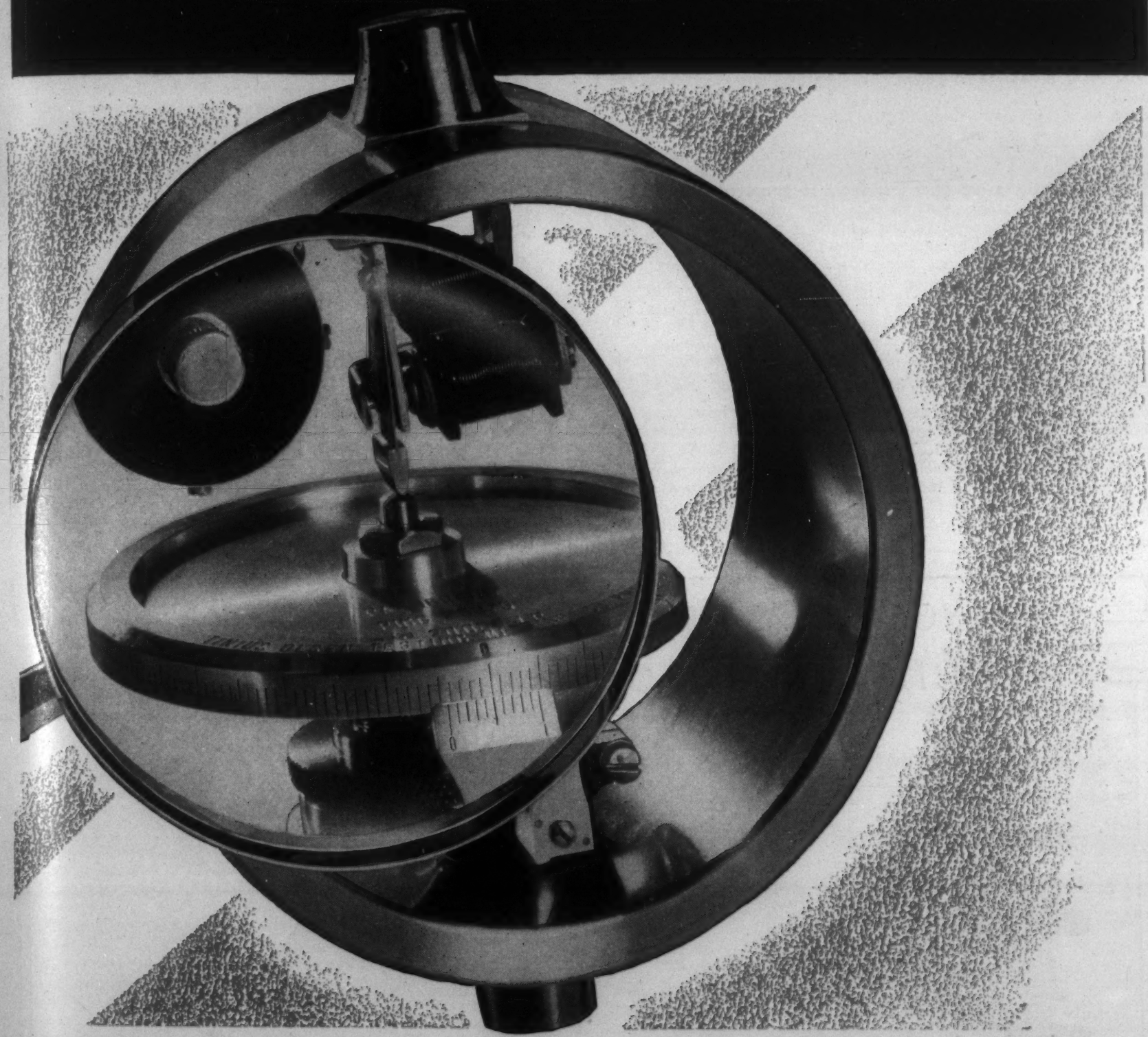

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Electrochemical Processes and Their Use for the Absolute Determination of Metal Surface Areas (Elektrochemische Vorgänge und ihre Auswertung zur Absolutbestimmung von Metalloberflächen) OTTO ERBACHER. *Chem. Ztg.*, Vol. 62, Aug. 20, 1938, pp. 601-604. Original research. Electrolytic deposition without application of electrical energy is a spontaneous interchanging of nobler ions with less noble metal atoms, the deposition of the nobler ions being brought about by local elements. There is another type of deposition, in which the interchange takes place at the very same spot, giving a mono-atomic coating. This occurs when the velocity of solution of the nobler atoms is greater than the velocity of discharging of the nobler ions (by local elements). This process allows the experimental determination of the absolute area of metal surfaces. It is, moreover, possible to determine the active area of noble metals by loading them with H and using the activated H for the electrochemical interchange with nobler ions. RPS (T-8)

A New Smoothness Tester. V. SEKIGUCHI & I. HASEGAWA. *Mech. Eng.*, Vol. 60, Oct. 1938, pp. 751-755. After a brief review of methods for measuring roughness and smoothness of a surface, a new method is described that uses a needle set at an angle of about 80° to the normal line on the surface to be tested, with the curved part near the point of the needle in contact with the surface. By means of a rectilinear reciprocating motion, the needle vibrates along the uneven parts of the surface; the vibrations are transmitted to one end of a pair of Rochelle salt crystals, the other end being fixed, thus generating piezoelectricity. The piezoelectric variations are recorded in the usual way; the amplitudes show the degree of smoothness. The practical arrangement is described in detail and examples of measurements given. Ha (T-8)

Preliminary Lists of Terms for the Arc and Spark Spectra of Tungsten. DONALD D. LAUN. *J. Research Natl. Bur. Standards*, Vol. 21, Aug. 1938, pp. 207-224. Original research. The new large quartz-prism spectrograph of the NBS has been used to photograph the arc and spark spectra of W in the ultraviolet between 3,100 and 2,100 A.U. WAT (H-8)

Use of X-rays for Controlling Welding in Aeronautical Work (L'Impiego dei raggi X per il controllo delle saldature aeronautiche) G. CALBIANI (Falck Iron Steel Works) *Met. ital.*, Vol. 30, July 1938, pp. 367-386. A summary with 41 illustrations. AWC (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Influence of Round Notches and Drilled Holes on the Repeated Bending Strength of Bars with Reduced Sections (Einfluss von Hohlkehlen an abgesetzten Wellen und von Querbohrungen auf die Biegewechselfestigkeit) E. LEHR & R. MAILÄNDER. *Arch. Eisenhüttenw.*, Vol. 11, May 1938, pp. 563-568. Original research. The effect of round filleted reduced sections and drilled transverse holes in test pieces 9 and 30 mm. in diameter on the endurance limit in reversed bending tests on various C and alloy steels was determined. For equally filleted reduced sections and equal diameter holes per diameter of specimen, the endurance limit was higher the harder the steel. With abruptly reduced sections, however, the endurance limit was not much higher for the harder steel. That is, the per cent decrease in endurance limit because of notches and holes was greater in the harder steels. This decrease was small, however, with well-filleted notches. The notch effect was greater in thicker specimens than in thinner. The effect of specimen size was about the same in the different steels, this being in general insignificant except in the case of sharply notched specimens. SE (8a)

Dynamic Tensile Properties of Light Metals at Low Temperatures (Dynamische Festigkeitseigenschaften von Leichtmetall-Legierungen bei tiefen Temperaturen) KARL BUNGARDT. *Z. Metallkunde*, Vol. 30, July 1938, pp. 235-237. Experimental. Fourteen common alloys of Al and Mg were tested at room temp., —35° and —65° C. The bending endurance limit increased with decreasing temp., especially for Al-Cu-Mg. Al — 4.68% Mg, and Mg-Mn alloys, while there was very little temp. effect in Al alloys with higher Mg content or the Mg-Al alloys. The notch sensitivity, with the exception of the Al alloys containing 7.73% Mg and 0.98% Zn which were unaffected, became greater at low temp. GD (8a)

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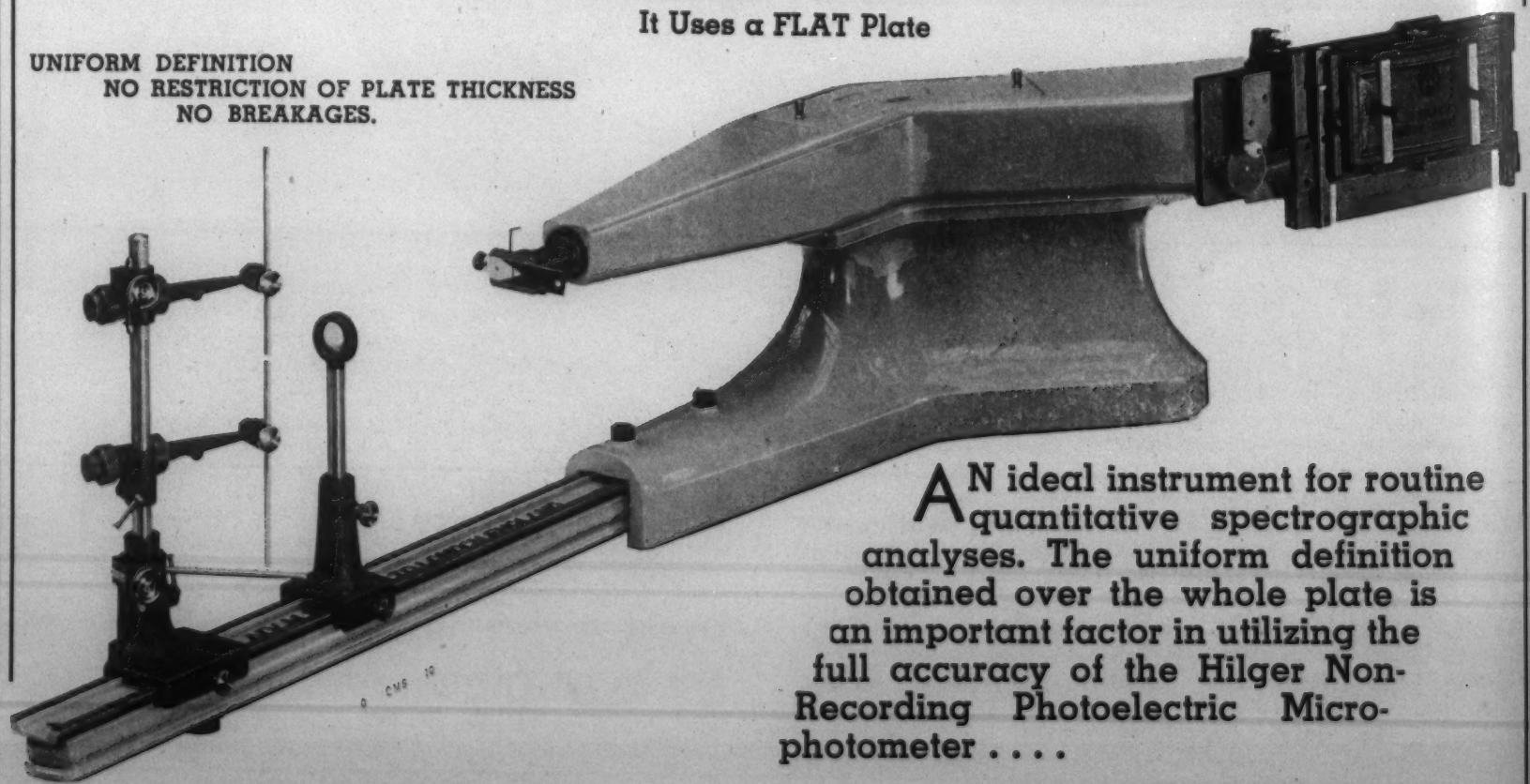

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Fatigue Tests of Riveted Joints. W. M. WILSON & F. P. THOMAS. *Univ. Illinois Eng. Expt. Sta.,* Vol. 35, May 31, 1938, Bulletin 302. Original research. For all fatigue tests endurance limit was determined on the basis of 2,000,000 cycles of stress. Tests in which rivets failed showed an endurance limit of the order of 30,000 lb./in.^{2} shearing stress for cycles of stress varying from zero to a maximum in one direction. Tests under reversed stress gave a wide scatter of results ranging from 15,000 to 30,000 lbs./in.^{2} Rivets stood up better under reversed stress in joints with plates having milled ends. The fatigue strength of high-strength bolts, with nuts screwed up to give high bolt tension was as great as that of well driven rivets. There was some evidence that the ratio of fatigue strength under reversed stress to fatigue strength under repeated stress is less for rivets than it is for the plates of a riveted joint. Fatigue tests in which failure took place in the plates gave some evidence that the influence of range of stress in a cycle on endurance limit may be represented by the Moore and Kommers formula $FL' = \frac{3\,FL}{2 - r}$ in which FL is the endurance limit for completely reversed stress r is the ratio of minimum to maximum stress, and is negative for a complete or partial reversal, and FL' is the endurance limit for any particular value of r. Increasing the ratio of unit bearing to unit tension from 1.17 to 2.35 did not affect the endurance limit for joints with high friction between plates. There was some evidence that decreasing the transverse distance between the rivets from 7 in. to 3⅝ in. increased fatigue strength of carbon-steel plates. The method of making rivet holes—punching, sub-punching and reaming, or drilling—did not appreciably affect the fatigue strength of either carbon steel or silicon steel plates for holes 1 1/16 in. diam. and plates ½ in. thick. The fatigue strength of plates in a riveted joint of balanced design under stress varying from 0 to max. tension was approx. 26,000 lb./in.^{2} for carbon steel, silicon steel, or nickel steel. Fatigue strength obtained from tests of small polished specimens is unreliable for design purposes owing to the stress-raising effect of rivet holes and rolled surfaces. The higher the strength the greater its sensitivity to stress raisers.

Ha + HFM (8a)

Bending-Fatigue Strength of Welded Rails (Ueber die Dauerbiegefestigkeit von geschweissten Schienen) O. GRAF. *Autogene Metallbearbeit.,* Vol. 31, Aug. 15, 1938, pp. 255-266; Sept. 1, 1938, pp. 271-279. Unusually comprehensive investigation of new and used rails with regard to endurance bending and tensile strength for straight butt-, oblique butt-, welded and lap joints. Welded joints were far superior to lap joints. Rails from various sources showed originally about 32,000-41,000, and one 60,000 lbs./in.^{2} bending-fatigue strength for 1 million reversals. In used rails, which were slightly rusty and showed notches caused by traffic or handling, the bending-fatigue strength was much reduced, sometimes to only 15,000 lbs./in.^{2} due to the presence of notch effects. The tests are described in great detail and illustrated by many photographs of structure, fractures and constructional details. 20 references.

Ha (8a)

Corrosion Fatigue. A. E. JENSEN. *J. So. African Inst. Engrs.,* Vol. 36, July 1938, pp. 273-281. Survey. Experimental results of many investigators on the effect of corrosion on the endurance of materials are considered, particularly on ferrous metals. The types of machines employed for the determination of endurance limits are described and illustrated. There is a serious effect of a mild corrosive agent such as 0.2% H_2SO_4 solution on mild steels while undergoing cyclic variation of stress. Such weakening is common to practically all materials. The loss in fatigue resistance is not proportional to the amount of material converted into the corrosion-product.

WHB (8a)

The Bending Strength of Lead and Lead Alloys (Zur Schwingungsfestigkeit von Blei und Bleilegierungen) KLAUS V. HANFFSTENGEL & HEINRICH HANEMANN. *Z. Metallkunde,* Vol. 30, Feb. 1938, p. 51. Experimental. Alternating cycle bending tests were made on (a) 99.99% Pb, (b) Pb alloyed with 1.2% Sn, 0.2% Cd, and 0.1% Sb, (c) Pb with 0.07% Ca, and (d) Pb with 1% Sb, 0.05% As. The tests, which were carried only to ten million cycles (at 12 cycles per second) showed that the bending strength was directly proportional to the hardness, the alloys ranging themselves in the order listed with pure Pb the weakest.

GD (8a)

Eudurance Strength with Alternating Temperatures (Dauerstandfestigkeit bei wechselnden Temperaturen) GEORG WELTER. *Z. Metallkunde,* Vol. 30, June 1938, pp. 195-198. Experimental. Endurance tests with constant load and temp. alternating between −60° and +70° C. were made on Cu wires, because of the need for such data for high tension lines and similar installations. The effect is to increase the rate of the initial rapid elongation over that normally shown at room temp., but there is little change in the later slow extension. The influence of alternating temp. is less than that of the maximum temp. of the cycle if a test is made at this high temp.

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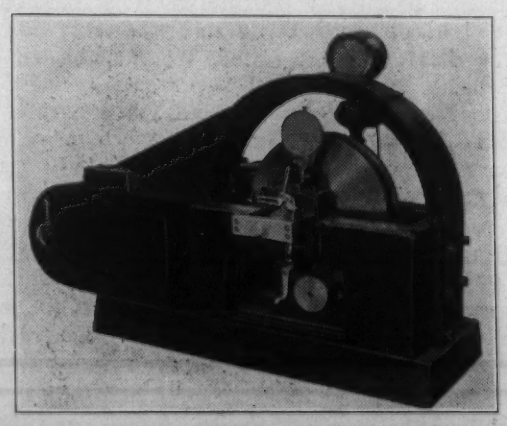

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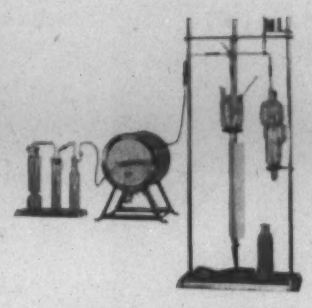

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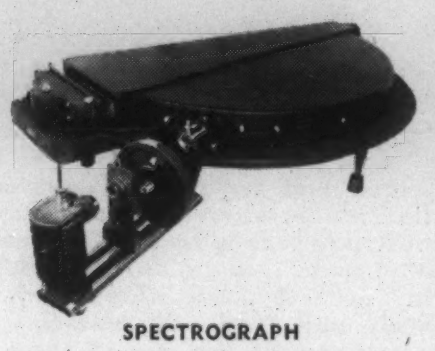

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Design-stress Diagrams for Alternating Plus Steady Loads. J. B. KOMMERS (Univ. Wisconsin) *Product Eng.*, Vol. 9, Oct. 1938, pp. 395-397. Review plus new data. Discusses the utility of the Goodman diagram, suggests a new formula and type of diagram for determining safe stresses for parts subjected to alternating plus steady loads, and offers test data and practical applications of the suggested diagram and formula for 3 steels [0.27, 0.37 (sorbitic) and 0.62% C.] The chief objections to the Goodman diagrams are (1) the lack of corroborative evidence, (2) the fact that the endurance ratio of .33 assumed by the Goodman diagram does not agree with frequent experimental observations that the average endurance ratio for wrought ferrous metals is close to .50, and, most important, (3) that part of the diagram lying between the yield point and ultimate tensile strength is useless practically because a cyclic maximum stress in excess of the yield point of a material would never be desirable. A new type of diagram is suggested, from which—in conjunction with certain formulas given in the text and a knowledge of the endurance limit for completely reversed stressing and yield point of the material—the designer can very easily determine endurance limits for various combinations of alternating and mean stresses. In the new diagram, the upper unit of stress is taken as the static yield point; for steels with 2 yield points, the lower is chosen. When the alternating stresses are tension and compression, the tensile yield point is used; for torsional stresses the yield point in torsion is employed. The equations and diagram are recommended for use only when complete information on the various fatigue limits for different values of the ratio of minimum to maximum stress in a cycle is not available. Typical examples of the practical application of the formula are given. [Torsional yield strengths will have different values if determined from tests of solid specimens from values determined from tests, of thin-walled hollow specimens.—H.F.M.] Ha + FPP (8a)

The Tensile Stresses In a Bearing Metal Cast on to a Strip and the "Fatigue" Failure of Bearings. F. C. THOMSON, A. S. KENNEFORD & G. C. SEAGER. *Engineering*, Vol. 146, Aug. 26, 1938, pp. 235-236; Sept. 9, 1938, p. 295. Original research. Deals with a series of measurements on composite bars that provide some idea of the order of stresses in the white metal in bearings. Specimens used were rectangular strips, 0.02 in. thick, 6 in. long and 1 in. wide, on which, after tinning, 0.17 in. of bearing metal was cast. Gives derivation of formula used in calculating tensile strength of white metal. Discusses the variation of the coefficient of expansion of the backing metal, the effect of the thickness of white metal on the contraction stress and temperature effect. Gives results of tests on a special machine designed to superimpose rapidly pulsating compression stress on test piece subjected to tensile stress. Claims that small tension stresses in white metal bearings exert a harmful effect under contant hammering. **The Tensile Stresses in a Bearing Metal Cast on to a Strip and the "Fatigue" Failure of Bearings.** J. DICK. *Ibid.*, Sept. 9, 1938, p. 299. Claims that in the calculations of effect of steel, support of white metal was omitted, and gives method of calculating the formula for estimating maximum stress in bearing metal. VSP (8a)

Preliminary Fatigue Studies on Aluminum Alloy Aircraft Girders, Goodyear-Zeppelin Corp. *Nat. Advisory Comm. for Aeronaut.*, Technical Note No. 637, Feb. 1938, 36 pp. Research. Using a special resonance fatigue machine, aircraft girders mounted with terminal shoes were magnetically vibrated at the natural frequency of the system, thus subjecting the girder section, about 3 ft. long, to alternate tension and compression. Girders of the types used on the Shenandoah, Los Angeles and Macon, and some experimental types, one a spot-welded design, were tested. A small proportion of the girders were run at low enough stress so that failure occurred at about a million cycles, but most of them were more highly loaded. On the whole, with girders of satisfactory design, the endurance curve lay at about ⅓ the stress of the corresponding curve for the heat-treated duralumin-type alloy of which they were made. The one spot-welded girder failed at a load and life far below the scatter band for the others. Rivet-holes, filled with rivets that were well squeezed down, were not as serious stress-raisers as were open holes. Punched and flanged open holes were notable locations of stress concentrations, but this is ascribed chiefly to residual stress or actual cracks from the flanging. The size of a hole in relation to the width of the material around the hole seemed to have an effect. Smaller holes gave better results. Old, unprotected girders that were somewhat corroded appeared somewhat injured in fatigue. Some earlier tests were made from zero to a desired tensile stress. Strict comparisons were not possible, but in general, the results were not widely different whether the stress range was pulsating, from zero to tension, or reversed, from tension to compression. HWG (8a)

The Influence of Previous Repeated Stressing on the Number of Bending Overstresses Withstood and on the Endurance Limit in Bending of "Steel 37" (Der Einfluss einer Wechselvorbeanspruchung auf Biegezeit- und Biegewechselfestigkeit von Stahl St 37) H. MÜLLER-STOCK, E. GEROLD & E. H. SCHULZ. *Arch. Eisenhüttenw.*, Vol. 12, Sept. 1938, pp. 141-148. Original research plus review of prestressing, overstressing and "damage line" in fatigue testing. "Steel 37" is a low C structural steel. A test piece previously stressed for a short time above its endurance limit will endure more reversals at this stress than a previously unstressed piece. If the piece is previously stressed for a longer time, however, its endurance on stressing the second time is decreased. The endurance limit of a test piece damaged by prestressing does not decrease linearly with increased prestressing, but decreases slightly at first and then more rapidly. However, a specimen not too severely damaged by previous overstressing still possesses an endurance limit although this is lower than that of the fresh material. Similar results were obtained with the somewhat harder steel St 52. 10 references. [The above results in general are in harmony with Kommers' results, see *Metals and Alloys*, Vol. 9, Oct. 1938, p. MA 616.—H.F.M.] SE (8a)

Fatigue of Pb and Pb Alloys. K. ONO. *Nippon Kinzoku Gakukai-Si*, Vol. 2, June 1938, pp. 290-295. In Japanese. Original research. The fatigue of Pb was studied under 3 different conditions: Chill-cast, forged (self-annealed), and forged (100° C. annealed). The fatigue strength was the best in the chill-cast state. The influence of gas atmosphere on fatigue was next examined; CO_2 raises the fatigue strength but O_2 lowers it; H_2 apparently has little effect. In wet O_2 the fatigue strength of Pb was found to be greater than in dry O_2. In still water, the fatigue strength was greater than in the air, as the action of O_2 is checked, but it was smaller than in H_2 atmosphere since water acts more or less as a corrosive agent. In the case of running water, fatigue was also greatly retarded because the cooling effect acts more than the corrosive effect of water. [It would be of interest to know the rate of repetition of stress, as this is a vital factor in the case of lead and some other very soft metals.—H. F. M.] NS (8a)

Some Aspects of Failures in Steel. ROBERT HUNTER. *J. West Scot. Iron Steel Inst.*, Vol. 45, Jan. 1938, pp. 41-63. Critical review from mathematical standpoint. Some of the current theories of elastic and fatigue failures of steel are discussed with regard to the derivation of the mathematical relationships. The type of stresses in fatigue failure are analyzed and the empirical and theoretical values compared. 23 references. FGN (8a)

9·METALLOGRAPHY

Structure and Constitution.

J. S. MARSH, SECTION EDITOR

Note on Heat of Self-diffusion (Notiz zur Selbstdiffusionswärme) J. A. M. VAN LIEMPT. *Rec. Trav. Chim.*, Vol. 57, July/Aug. 1938, pp. 891-892. In German. Original research. Demonstrates how the formula for self-diffusion advanced by Cichocki

$$Q = \frac{V}{8\chi}$$

(Q = self-diffusion heat, V = atomic volume, χ = coefficient of compressibility) can be converted into the equation set forth by the author

$$Q = 32\ T_s$$

(T_s = abs. melting point). A table lists values of V, χ and Q for 11 of the most important metals, showing that the Einstein constant is somewhat lower than calculated by him. EF (9)

New Methods for Studying Diffusion in Metals (Nouveaux Procédés pour l'Étude de la Diffusion Métallique) PIERRE CHEVENARD & ALBERT PORTEVIN. *Compt. Rend.*, Vol. 207, July 4, 1938, pp. 71-73. General description. The direct method for determining the rate of diffusion of one metal in another has to do with the change in concentration at a point or a surface as shown by chemical microscopy or spectrography. Indirect methods suitable are as follows: (1) Variation of properties in alloys, compressed powders, or welded layers as diffusion proceeds. (2) Changes in resistivity during diffusion. (3) Changes in the curvature during heating of 2 Fe-Ni alloys, *e.g.* 25 and 36% Ni, as the Ni in the 2 layers becomes diffused. (4) Changes in the Curie point of ferromagnetic alloy as the concentration varies due to diffusion. FHC (9)

A Simple Method for Finding All Possible Solutions of the Problem of Indexing X-ray Powder Spectrograms of Complex Cubic Crystals. V. N. PROTOPOPOV. *Zhur. Eksptl. i Teor. Fiz.*, Vol. 8, Apr. 1938, pp. 498-505. In Russian. Theoretical. Detailed description of a new method for the evaluation of X-ray powder spectrograms of complex cubic systems using geometrical data only. The determination of the indices ($p_1p_2p_3$) does not depend on the presence of "first" lines or the absence of some other lines in the spectrogram. The indices are determined independently of the lattice constant a, and vice versa. In both cases, the solutions are multi-valued. For the selection of the correct solution, additional data are required. The method is illustrated on the X-ray powder spectrogram of pyrite. ORS (9)

Features of Strain Detection by X-rays as Compared to Mechanical Strain Measurement (Die Besonderheiten des Röntgenographischen Spannungsmessverfahrens im Vergleich zur mechanischen Spannungsmessung) H. MÖLLER. *Arch. Eisenhüttenw.*, Vol. 12, July 1938, pp. 27-31. Review of previous work, and new determinations of strain in thick steel plates by means of X-ray crystallograms and by mechanical measurements. By means of the latter an indication of the strains throughout the plate may be obtained, while X-rays give an indication of the strains only near the surface. Se (9)

Thermomagnetic Bi-anisotropy of Crystals. N. S. AKULOV & R. G. ANNAYEV. *Zhur. Eksptl. i Teor. Fiz.*, Vol. 8, Mar. 1938, pp. 334-341. In Russian. Theoretical. A new method for measuring thermomagnetic properties of ferromagnetic crystals is described in detail. The effect of the bi-anisotropy of these crystals on their thermomagnetic properties has been determined. The relation between the thermomagnetic effect and the mutual position of the magnetizing force, temp. gradient and the crystal axes is treated analytically. ORS (9)

Gases in Metals and Their Influence, Adsorption, Absorption and Chemical Reactions. HENRY LEPP. *Metal Ind., London*, Vol. 53, July 8, 1938, pp. 27-30; July 15, 1938, pp. 59-63; July 22, 1938, pp. 79-83; July 29, 1938, pp. 103-107; Aug. 5, 1938, pp. 131-136. Unusually comprehensive review. English version of a paper originally published in *Bull. Assoc. Tech. Fonderie* (see *Metals and Alloys*, Vol. 9, Mar. 1938, p. MA 184R/2). 89 references. RWB (9)

Properties of Interacting Electrons in Metals. V. A. SAVEL'YEV. *Zhur. Eksptl. i Teor. Fiz.*, Vol. 8, Jan. 1938, pp. 13-23. In Russian. Theoretical. Employing the method of configurational space with asymmetrical functions, the effect of the exchange interaction of electrons in a metal on the distribution of the energy levels is analyzed. The results of the mathematical analysis are used in an approximate determination of the relative amounts of the electric and thermal conductivities, as well as of the heat capacity at constant volume, which are due to the interaction of electrons. It is shown that the interaction of electrons contributes to the conductivities, its effect increasing with decreasing temp. ORS (9)

On the Interaction of Atoms in Alloys. WILLIAM SHOCKLEY (Bell Tel. Lab.) *J. Chem. Phys.*, Vol. 6, Sept. 1938, pp. 523-525. Original theoretical research. A generalization of Bethe's theory of superlattices, so as to take into account the interactions between atoms that are not nearest neighbors in the lattice, is considered. This procedure will not furnish any great improvement in agreement between theory and experiment because it predicts, in disagreement with experiment, that many properties of binary alloys are symmetrical between the 2 constituents. It is further shown to be in disagreement with certain fundamental features of the interactions of atoms in alloys. EF (9)

Atomic and Tonic Radii.—I. Numerical Values and Their Bearing on the Compressibilities of Metals. WM. HUME-ROTHERY & G. V. RAYNOR. *Phil. Mag.*, Vol. 26, July 1938, pp. 129-143. **II. Application to the Theory of Solid Solubility in Alloys.** *Ibid.*, pp. 143-152. **III. Polarization Effects in Alloys.** G. V. RAYNOR. *Ibid.*, pp. 152-165. Theoretical review. The compressibilities of elements and alloys as influenced by their atomic radii and interatomic distances, and the various theories on metallic properties based on electronic and atomic theories are discussed exhaustively. 38 references. Ha (9)

Measurement of the Tensile Strength During a Transformation (Versuche zur Feststellung der Festigkeit in Umwandlungspunkten) FRANZ ROLL. *Z. Metallkunde*, Vol. 30, July 1938, pp. 244-245. Experimental. A series of rapid tensile tests were made at different temp. on Fe, S and Sn. There is a marked lowering of the tensile strength at 900° for pure Fe, which is slightly lower for Armco Fe. The same phenomenon is observed at about 92° for S. Sn wires show an irregularity at 165°. GD (9)

The Solubility of Components in Their Crystallizing Compounds (Zur Löslichkeit der Komponenten in ihren Kristallisierten Verbindungen) G. TAMMAN. *Z. anorg. allgem. Chem.*, Vol. 236, Mar. 12, 1938, pp. 306-309. Theoretical. The case of binary systems having one intermediate compound is discussed. It is indicated that at ordinary temp. the solubility of either of the components in this compound becomes vanishingly small. Although most intermetallic compounds may be looked upon as compounds of singular composition, the possibility of a small solubility is not excluded. HFK (9)

9a. Ferrous

J. S. MARSH, SECTION EDITOR

The Dendritic Segregation of Steel Ingots. M. HAMASUMI. *Nippon Kinzoku Gakukai-Si*, Vol. 2, May 1938, pp. 193-202. In Japanese. Original research. Dendritic segregation in a 20-ton acid open-hearth Ni-Cr steel was studied. Sheets 1 mm. thick weighing 1 kg. were cut off from the rough-forged ingot, polished and etched with a macro-etching solution. Chemical analyses of the dissolved material were made and the composition of the dendritic skeleton calculated by weighing before and after the etching. The results on a flaked ingot were as follows:

	C %	Ni %	Cr %	Mn %	P %
Ladle analysis	0.26	3.40	0.78	0.57	0.028
Analysis of sheet	0.28	3.38	0.87	0.52	0.030
Dendritic skeleton	0.31	3.16	0.74	0.58	0.025
Inter-dendritic filling	0.28	3.49	0.94	0.51	0.047

NS (9a)

Electrolytic Determination of Non-metallic Inclusions in Steel (Beitrag zur elektrolytischen Bestimmung von nichtmetallischen Einschlüssen im Stahl) P. KLINGER & W. KOCH. *Arch. Eisenhüttenw.*, Vol. 11, May 1938, pp. 569-582. Critical review and original research. A new electrolytic extraction method is described in which a sodium citrate-potassium bromide-potassium iodide solution is used. The main feature of the procedure is that the separation of the inclusions is performed in a constantly flowing neutral solution continuously replenished by fresh electrolyte. Anodic oxidation is thus avoided. The anode chamber is not restricted by a collodion bag. Under these conditions the oxide residue is not attacked. Carbides and sulphides are first separated from the residue and SiO_2, Al_2O_3, FeO, and MnO are then determined. Analyses were made on 0.01 to 1.2% C steels containing from 0.03 to 1.0% Mn and from 0.01 to 1.0% Si. Concordant results in good agreement with other methods were obtained. SE (9a)

Structure of Gray Cast Iron (Nouvelles Recherches sur la Fonte Grise et la Formation de sa Texture) F. GIRARDET. *Bull. Assoc. Tech. Fonderie,* Vol. 12, Mar./Apr. 1938, pp. 35-45. Research. A method for the study of the macrostructure of cast Fe is described and some conclusions resulting from this study are given. The polished specimen is anodically etched to develop a network structure. The appearance of this structure is associated with the raw materials, the melting method, and the physical properties of the casting. From the macroscopic structure of cast irons, it is concluded that the liquid metal is not a single homogeneous phase, but rather an emulsion or dispersion of several liquid, solid or gaseous phases in the more abundant phase. The liquid metal does not pass from the liquid to the solid state by the formation of crystalline elements, but passes through an intermediate state as an emulsion of liquid droplets. WHS (9a)

The Magnetic Relations in Hardenable Ferritic Iron-nickel-copper Alloys (Ueber das magnetische Verhalten aushärtbarer ferritischer Eisen-Nickel-Kupfer-Legierungen) WALTER DANNÖHL. *Z. Metallkunde,* Vol. 30, Mar. 1938, pp. 95-99. Discussion with original data. According to earlier work (*Metals and Alloys,* Vol. 8, Dec. 1937, p. MA 764 R/10) the magnetic hardness of "irreversible" Fe-Ni alloys is not due to the transformation of residual austenite to martensite by annealing, but rather to the re-formation of austenite. The annealing of Fe-Ni-Cu alloys produces new austenite and a Cu precipitate simultaneously. In an alloy of 12% Ni and 15% Cu, $H_c = 328$ oersteds at $B_r = 3920$ gausses was obtained. Cooling to —182° C. causes decomposition of the austenite formed by annealing and is accompanied by a marked decrease of the coercive force while the magnetic saturation and the remanence increase. GD (9a)

On the Allotropy of Stainless Steels. FREDERICK MARK BECKET (Union Carbide & Carbon Res. Labs.) *Metals Tech.*, Vol. 5, June 1938, 22 pp. An up-to-date review of the significance of structural changes on the properties of steels of the stainless type. Particular attention is paid to the embrittling action of the σ phase in high-Cr alloys, although this phase is not held responsible for the familiar "475° brittleness" in stainless steels. The author questions the widely accepted theory that "intergranular corrosion" of these steels is caused by precipitation of Cr-rich carbides at the grain boundaries, with consequent depletion of Cr in the solvent alloy nearby. He describes this increased corrodibility to internal strain resulting from the $\gamma \rightarrow \alpha$ transformation in the Fe. JLG (9a)

Electric Charges in Solid Solutions (Electrische Ueberführungen in festen Metallegierungen) W. SEITH & TH. DAUR. *Z. Elektrochem.*, Vol. 44, Apr. 1938, pp. 256-260. Original research. Charges of the carbide and boride ions in solid solution with Fe are positive; that of the nitride ion is negative. D.c. was passed through a high-purity Fe wire 1.5 mm. in diameter and 50 cm. long for 3-22 hrs. *in vacuo* at 900°-1100° C. A section 1 cm. long in the middle of the wire contained the element under consideration, in solid solution. Examination of wire on either side of this section after electrolysis showed whether the ion migrated toward the anode or cathode. Prolonged treatment with Ni and Si as solutes gave no results. FFF (9a)

Absorption of Hydrogen and Nitrogen by Pure Iron. K. IWASE & M. FUKUSIMA. *Sci. Repts. Tohoku Imp. Univ.*, Vol. 27, Sept. 1938, pp. 162-188. Original research. English version of a paper originally published in Japanese. See *Metals and Alloys,* Vol. 9, Apr. 1938, p. MA 246 R/1. AUS (9a)

"TRENDS" . . .

brief but significant—to the point. See page MA70.

A New Charging Device for a Vacuum Fusion Furnace for Analyzing Oxygen in Steel (Neuartige Beschickungsvorrichtung für Öfen zur Bestimmung des Sauerstoffs im Eisen nach dem Heissextraktionsverfahren) F. WILLEMS. *Arch Eisenhüttenw.*, Vol. 11, June 1938, pp. 627-628. Descriptive. Drawings are shown of the glass connections serving as a very convenient magnetic charging device for introducing several samples successively into a spiral vacuum furnace; sticking in the passageways and interference with temp. measurement are obviated. SE (9a)

The Iron End of the Iron-silicon-titanium System (Die Eisenecke des Systems Eisen-Silizium-Titan) R. VOGEL & W. SCHLÜTER. *Arch. Eisenhüttenw.*, Vol. 12, Oct. 1938, pp. 207-212. Original research. The ternary diagram up to the compositions of the compounds FeSi and Fe_2Ti was determined by thermal analyses and microscopic examinations. Sections through the ternary diagram and microstructures of typical alloys are shown. SE (9a)

Thermal and X-ray Study of the System Iron-titanium (Thermische und röntgenographische Untersuchung im System Eisen-Titan) HELMUT WITTE & HANS-JOACHIM WALLBAUM. *Z. Metallkunde,* Vol. 30, Mar. 1938, pp. 100-102. Experimental. Thermal, microscopic and X-ray studies established the existence of the phase $TiFe_2$, melting at 1530° C. with the crystal structure of $MgZn_2$, a = 4.77 A.U., c = 7.79 A.U., c/a = 1.633. The previously reported phase $TiFe_3$ could not be found. GD (9a)

The Solubility of Hydrogen in Iron-tungsten Alloys (Die Löslichkeit von Wasserstoff in Eisen-Wolfram-Legierungen) W. BAUKLOH & K. GEHLEN. *Arch. Eisenhüttenw.*, Vol. 12, July 1938, pp.39-40. Original research. Curves showing the solubility of H_2 in Fe-W alloys containing up to 36% W at temp. up to 1050° C. are given. In general, W lowers the solubility of H_2 in Fe, particularly at higher temp. SE (9a)

9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

X-ray Analysis of Ni-Si Alloys. A. OSAWA & M. OKAMOTO. *Nippon Kinzoku Gakukai-Si,* Vol. 2, Aug. 1938, pp. 378-388. In Japanese. Original research. The results of the analyses are summarized in the Table:

Phase	Chemical Formula	Wt % Si	Crystal Class and Lattice Constant in A.U.	No. of Atoms in Unit Cell
α		0–5	Face-centered cubic $a=3.516_9$-3.510_0	4
β_1	Ni_3Si	13.0	Face-centered cubic $a=3.496_0$	4
γ	Ni_5Si_2	16.0	Orthohexagonal $a=13.28_9$, $b=7.672_1$, $c=9.751_8$	91
δ	Ni_2Si	19.3	Orthorhombic $a=7.39_2$, $b=9.90_2$, $c=7.03_6$	48
θ	Ni_2Si	23.0	Hexagonal $a=3.7970$, $c=3.892_8$	6
ϵ	Ni_3Si_2	24.3	Orthorhombic $a=6.605_4$, $b=7.627_2$, $c=9.574_0$	45
η	Ni Si	32.5	Tetragonal $a=7.653_8$, $c=8.451_4$, $c/a=1.104_4$	40
ζ	Ni Si_2	49.0	Rhombohedral $a=8.88_1$	54
ζ'	Ni Si_2	49.0	Mixed lines of ζ and Si (quenched from 990° C.)	
Si		= 100	$a=5.409_3$; 1-2% Ni probably soluble at high temperature.	

NS (9b)

The Cu-Sb Diagram. III. Transformations in the Solid State. T. MURAKAMI & N. SHIBATA. *Nippon Kinzoku Gakukai-Si,* Vol. 2, Aug. 1938, pp. 365-378. In Japanese. Original research. By means of differential dilatometric and electric resistance measurements and microscopic examination, the β region was further revised, and η and δ redetermined. θ is formed from β, γ and $Cu_{11}Sb_4$ by a peritectoid reaction at 440° C. and 58.95% Cu; β decomposes into θ and δ by the eutectoid reaction at 436° C. and 63.5% Cu. In cooling, although the peritectoid reaction is accompanied by expansion and decrease in electrical resistivity, the eutectoid reaction is accompanied by contraction and increase in electrical resistivity. The solubility range of η at δ peritectoid temperature (462° C.) and the eutectoid composition of the same phase are assigned as 73.5-74.1% Cu and 73.9% Cu, respectively. For previous work, see also *Metals and Alloys,* Vol. 9, Feb. 1938, p. MA 109L/4. NS (9b)

The Constitution of Cu-rich Cu-Si Alloys. T. ISAWA. *Nippon Kinzoku Gakukai-Si,* Vol. 2, Aug. 1938, pp. 400-409. In Japanese. Original research. By X-ray analysis, α solubility limit was determined as 4.99% Si at 800° C. and 3% Si at 300° C. A new phase forms by peritectoid reaction of α and β at about 6% Si and 830° C. The solubility range of the new phase at 780° C. and room temperature are given as 5.8-6.5% Si and 5.8-6.0% Si, respectively. The new phase has close-packed hexagonal lattice with $a = 2.552$ A.U., $c = 4.152$ A.U., $c/a = 1.626$, with 16 atoms or 2 molecules of Cu_7Si in its unit cell. β has body-centered cubic lattice with $a = 2.848$ A.U., and forms an intermediate phase. γ has about 1% solubility change above 600° C. The author would call the new phase "beta", and would call the phase now known as β, "epsilon". NS (9b)

An X-ray Study of Silver-zinc Alloys Rich in Silver, Below the β-transformation Temperature. E. A. OWEN & I. G. EDMUNDS. *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 808, 12 pp. Original research. The phase boundaries of the Ag-Zn system below the temperature of the β transformation were determined by X-ray methods. All the boundaries in this region of the accepted diagram require modification. The $\beta + \zeta$ phase field is found to be very narrow; its lower boundary reaches a minimum value at about 262° C. for an alloy containing about 65% Ag. This temperature is lower than either of the β-transformation temperatures in the adjacent duplex regions. **The Silver-zinc Equilibrium Diagram and the Structure of the ζ Phase.** *Ibid.,* Advance Copy No. 809, 11 pp. Original research. Results of the authors' work published in other papers on the Ag-Zn diagram is used in constructing an accurate Ag-Zn diagram. The ζ phase was investigated by means of X-ray analyses and found to possess a close-packed hexagonal structure with 54 atoms to the unit hexagonal cell. JLG (9b)

The Specific Heats of Beryllium Nitride, Phosphorus Nitride and Titanium Nitride. SHUN-ICHI SATOH. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Aug. 1938, pp. 888-896. In English. Original research. The specific heats of the nitrides of Be, P and Ti, not previously determined, were determined in the ice calorimeter. The following equation of the true specific heat of Be-nitride was established (temp. ranges: 0°-99.5° C., 0°-303.3° C., and 0°-500.3° C.) $C = 0.2726 + 7.884 \times 10^{-4}t - 5.163 \times 10^{-7}t^3$. The determinations on P-nitride at 0°-99.6° C. and 0°-305.3° C. yielded $C = 0.2027 + 6.252 \times 10^{-4}t$. The following equation expresses the true specific heat of Ti-nitride in the temp. ranges of 0°-99.6° C., 0°-305.3° C. and 0°-500.5° C.: $C = 0.14140 + 1.918 \times 10^{-4}t - 1.127 \times 10^{-7}t^3$. EF (9b)

The Distribution of Silicon in Aluminum. YU. A. KLYACHKO. *Zhur. Priklad. Khim.,* Vol. 11, Jan. 1938, pp. 190-191. In Russian. Original research. Preliminary report of results of a new method for determination of the distribution of Si among the different phases (free Si, Al-Si solid solution and SiO_2) in solid technical Al. The amount of SiO_2 was found to be proportional to the amount of Si in solid solution. The presence of SiO_2 in solid Al, despite the fact that SiO_2 and Al react with each other in the metal bath and contrary to thermodynamic reasoning, is explained in terms of the micellar structure of metals and is attributed to the known surface activity of Si in Al. ORS (9b)

Electron Diffraction Effects from Polished Zinc Surfaces. M. L. FULLER (N. J. Zinc Co.) *Metals Tech.,* Vol. 5, Sept. 1938, T. P. No. 965, 11 pp. Original research Under certain circumstances polished surfaces of Zn yield electron-diffraction effects that indicate the surface to be definitely crystalline. These effects are in the form of diffraction lines perpendicular to the shadow edge of the reflection type of photogram. Quantitative correlation was made with the hypothesis that the polished Zn surface consists of very minute crystals of Zn, oriented with their basal planes parallel to the plane of polish. Experimental evidence from the laboratory and from the literature have been adduced to show that the diffuse-halo pattern alone has no significance with respect to composition and crystal structure of a surface, and that whether or not such a diffraction pattern is obtained is dependent on the surface texture of the specimen. No rigorous explanation can be given for the genesis of the haloes. 29 references. JLG (9b)

The Constitution of Lead-rich Alloys of Lead and Cadmium. E. C. ROLLASON & V. B. HYSEL, with an appendix on **The Thermodynamic Analysis of Solutions of Cadmium in Lead.** E. C. ROLLASON. *J. Inst. Metals,* Vol. 63, 1938, Advance Copy 803, 10 pp. Original research. The constitution of Pb-rich Pb-Cd alloys was determined by means of heating and cooling curves, microstructures, and electric resistivity measurements on wires held at elevated temperatures. The eutectic is at 248° C. and 17.5% Cd. Pb dissolves 3.3% Cd at the eutectic temperature, 0.8% at 150° C., and 0.3% at room temperature. Thermodynamical analysis of the data indicate that both the liquid and solid solutions consist of monatomic molecules of Cd and Pb. The molal heat of fusion of Pb is calculated from the data on the diagram to be 5.80 cal./g., which agrees with the value obtained experimentally. JLG (9b)

The Polymorphism of MnSe (Sul Polimorfismo di MnSe) A. BARONI. *Z. Krist,* Vol. 99, July 1938, pp. 336-339. In Italian. Original research. Electron diffraction investigation disclosed 3 types of structure for MnSe similar to those found by Schnaase ZnS structure with a = 5.82 A.U. and tends to transform into the α modification. γ-MnSe is very unstable and crystallizes with a for MnS (*Z. phys. Chemie,* (B) 1933, p. 89). α MnSe has NaCl structure with a = 5.44 A.U. The unstable β MnSe possesses wurtzite structure. The dimensions of the elementary cell are a = 4.12 A.U., c = 6.72 A.U., c/a = 1.63. EF (9b)

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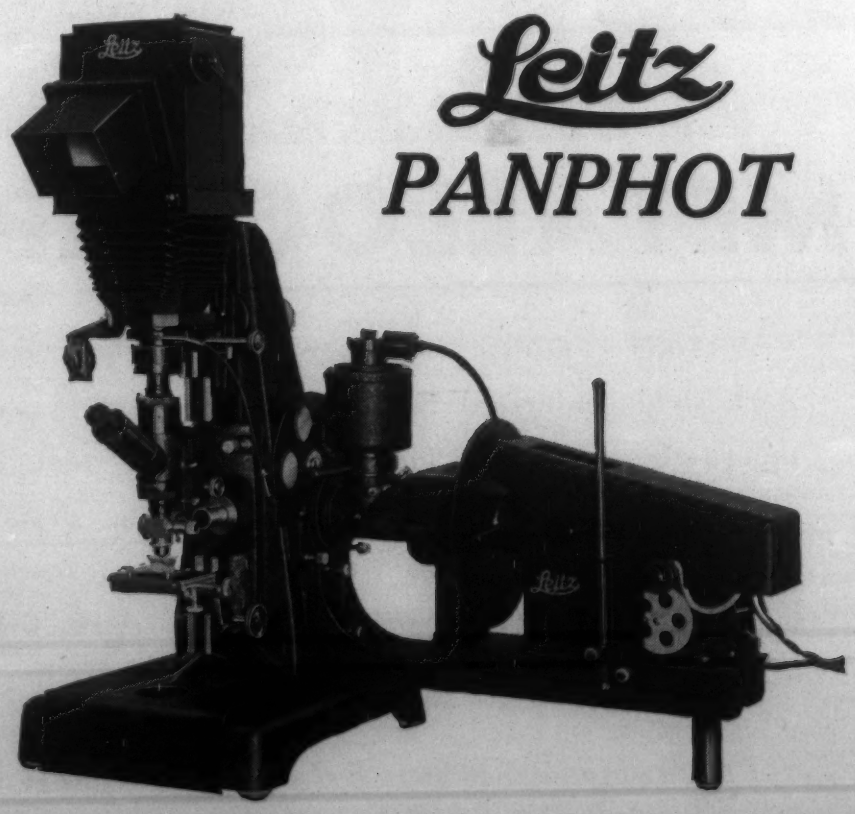

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On the K Phase Adjacent to the Alpha in the Copper-silicon System. M. OKAMOTO. *Sci. Repts. Tohoku Imp. Univ.*, Vol. 27, Sept. 1938, pp. 155-161. In English. Original research. Microscopic and X-ray study was made of certain binary Cu-Si alloys after various heat-treatments. The Si content was varied from 4 to 8%. The existence of the newly discovered K-phase was confirmed, and the limits of its existence were partially defined. Evidence of the K (hexagonal) phase was found from 4.5% to 7.5% Si from the X-ray data. Only K-phase lines were found in the 5.5% alloy. The K-phase seems to be characterized microscopically by a very heavily banded, or twinned-like structure. Various etching agents were used in an effort to find some selective etching agent to differentiate the α and K constituents, but with indifferent success. After quenching alloys ranging from 4.5 to 6.5% Si from 800° C., the structure of the co-existing α and K-phases remained unchanged. The 6% alloy was homogeneous K-phase. The alkaline potassium ferricyanide solution of H. Imai gave as satisfactory an etch for these alloys as anything used. The alloys investigated cannot be considered to have attained equilibrium. AUS (9b)

An X-ray Study of Silver-zinc Alloys Rich in Silver Above the β-transformation Temperature. E. A. OWEN & I. G. EDMUNDS. *J. Inst. Metals*, Vol. 62, 1938, Advance Copy 801, 14 pp. Original research. An account is given of an X-ray examination of the $\alpha - (\alpha + \beta) - \beta - (\beta + \gamma) - \gamma$ boundaries of the Ag-Zn diagram. Results showed that the position of these boundaries as given in the most recently published diagrams need modification. JLG (9b)

The Constitution of the Alloys of Tin with Bismuth. A. C. DAVIDSON. *Tech. Pub. Intern. Tin Research Development Council*, Ser. A. No. 77, Aug. 1938, 14 pp. Review plus original research. Eutectic is 57% Sn at 138.50° C. Solubility of Bi in Sn ranges from over 21% at eutectic temperature to less than 1% at room temperature. Solid solubility of Sn in Bi is between 0.1 and 0.2% Sn at the eutectic temperature. BWG (9b)

Alloys of Mg and Ga, In and Tl (Ueber Legierungen des Mg mit Ga, In und Tl) W. HAUCKE. *Naturwiss.*, Vol. 35, Sept. 2, 1938, pp. 577-578. Original research. Mg and Ga form 4 compounds: Mg_5Ga_2, Mg_2Ga, MgGa and a compound with over 50 atomic % Ga. Mg and In form Mg_5In_2, Mg_3In, MgIn and $MgIn_3$. Only 3 intermetallic compounds are present in the Mg-Tl system: Mg_5Tl_2, Mg_2Tl and MgTl. JZB (9b)

Factors Affecting the Liquidus, Solidus and Solid-solubility Curves in Some Alloys of Magnesium. WILLIAM HUME-ROTHERY & GEOFFREY VINCENT RAYNOR. *J. Inst. Metals*, Vol. 63, 1938, Advance Copy No. 805, 17 pp. Original research. Factors affecting the solubilities of the B sub-group elements in solid Mg are discussed, with special reference to metals of Group IIIB. The fact that solid Zn and Cd have a smaller tendency to form solid solutions than Mg has is explained on the basis of the modern electron theory of metals. Of the elements of Group IIIB, Ga is outside of the zone of favorable size-factor for Mg, and forms a very restricted solid solution, the maximum solid solubility being 3.14 at. % Ga. Al is on the border line of favorable size-factor, and its solubility in Mg, which is very small at low temperatures, increases to 11.5 at. % at high temperatures, as compared with 19.35 at. % In and 15.4 at. % Tl for the 2 systems where the size-factor is favorable. Relations existing between the liquidus, solidus and solid-solubility curves are discussed. JLG (9b)

The Constitution of the Magnesium-rich Alloys in the Systems Aluminum-magnesium, Gallium-magnesium, Indium-magnesium, and Thallium-magnesium. WILLIAM HUME-ROTHERY & GEOFFREY VINCENT RAYNOR. *J. Inst. Metals*, Vol. 63, 1938, Advance Copy No. 804, 26 pp. Original research. Equilibrium diagrams for Mg-rich Al-Mg, Ga-Mg, In-Mg and Tl-Mg alloys were determined. Liquidus and solidus curves for the Mg-rich α solid solutions were determined in all 4 systems, and the α solid solubility curve was determined in detail for the alloys with Ga, In and Tl. The liquidus curve for the Al-Mg system is distinctly higher than that of previous diagrams, but agrees well with the values given by Haughton and Payne for ternary Al-Cd-Mg alloys. In the system Tl-Mg, the solid solubility of Tl in Mg is greater at high temperatures and smaller at low temperatures than was previously supposed. The liquidus curve for the more concentrated alloys is higher. JLG (9b)

The Atomic Resistance Increase of Diluted Lead Alloys between 273° and 14° Absolute (Die atomare Widerstandserhöhung verdünner Bleilegierungen zwischen 273 und 14° abs.) A. EUCKEN & H. SCHÜRENBERG. *Ann. Physik*, Ser. 5, Vol. 33, Sept. 1938, pp. 1-20. Determination of numerical values and derivation of formulas for calculation are given. The solubility of Cd, Sb and Mg in Pb was found to be considerably less at room temperature than usually accepted. 20 references. Ha (9b)

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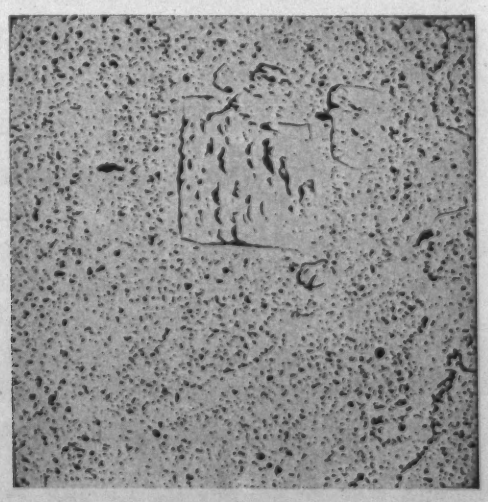

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10 · PROPERTIES AND APPLICATIONS

Including Relation of Properties to Engineering or Product Design. See also Sections 8a and 11.

M. GENSAMER, SECTION EDITOR

Stress-strain Relations under Tension Impact Loading. D. S. CLARK & G. DÄTWYLER (Calif. Inst. Tech.) *Am. Soc. Testing Materials,* Preprint, June 1938, 9 pp. Discusses a method of determining force-elongation diagrams for metals under tension impact loads. A new type of tension dynamometer is described, and results of tests on a few steels and non-ferrous metals and alloys at a velocity of about 11 ft./sec. are given. The reliability of this method has been demonstrated by the agreement shown between the measured and computed values of energy and elongation. The dynamic force-elongation diagrams for several materials were determined and compared with the static diagrams of the same materials. In most of the cases considered, it was found that the yield and maximum forces are higher with dynamic loading than with static loading. There is some indication that the physical properties of cold-worked materials in dynamic tension are superior to those in static tension. These cold-worked materials show considerably more elongation, and in some cases greater reduction in area, when loaded dynamically than when loaded statically. The results obtained with 18-8 Cr-Ni and 17S-T duralumin indicate that these 2 materials may possess very low critical velocities. VVK (10)

Cobalt and Its Alloys (Le Cobalt et ses Alliages) J. CHALLANSONNET. *Tech. Moderne,* Vol. 30, July 15, 1938, pp. 483-489. Comprehensive review. Pure Co is similar to Ni except that its tensile strength is higher (71,000 lbs./in.^{2} compared with 60,000 lbs./in.^{2} for Ni) and its Curie point is 1,150° C. (Ni is 540° C.). Masumoto alloys with 54% Co, 36.5% Fe and 9.5% Cr are corrosion resistant and have a coefficient of expansion 1/12 of that of Invar. Ni-Co alloys are used for magnetic temperature regulators, as the Curie point varies directly with composition. Hastelloy A with 56% Ni, 22% Fe, 19.5% Co and 2.5% Mn is easily worked and used for high corrosion resistance (e.g. against concentrated HCl at 80° C.). Konel with 70% Ni, 19.5% Co, 7.4% Fe and 2.8% Ti is used for elevated temperature strength. Primary use of Co is in high speed steels to increase cutting efficiency. Since 1910 high speed steels with 5-20% Co have been used for special purposes, although decarburization must be carefully guarded against. The heat treatment is somewhat different from that of the usual 18-4-1 and 14-4-2 types in that the austenite is very resistant to tempering, and several temperings are necessary to obtain a thoroughly martensitic matrix. JZB (10)

Rough Compressibilities of Fourteen Substances to 45,000 kg./sq. cm. P. W. BRIDGMAN (Harvard Univ.) *Proc. Am. Acad. Arts Sci.,* Vol. 72, Feb. 1938, pp. 207-225. Original research. The apparatus previously used for measuring transitions at high pressures (*Metals and Alloys,* Vol. 8, Feb. 1937, p. MA 101L/6) has been employed for rough measurements of compressibilities up to 45,000 kg./cm.^{2} (650,000 lbs./in.^{2}). The following elements were tested: Pb, Sn, In, Ba, Sr, Ca, Cs, Rb, Li, Na, K. The experimental results are in fair agreement with theoretical calculations of compressibilities based on wave mechanics. Data obtained are also checked against Murnaghan's formula of elasticity (*Am. J. Math.,* Vol. 59, 1937, p. 235) dealing with relation between stress and strain for finite strain. EF (10)

The Crinkling Strength and the Bending Strength of Round Aircraft Tubing. *Nat'l Advisory Comm. for Aeronaut.,* Report No. 632, 15 pp. A study of the upper limit of column strength or crinkling strength and bending strength of thin walled, round, aircraft tubing of normalized Cr-Mo steel and duralumin, heat treated and cold drawn to a relatively high tensile yield strength. Equations developed from empirical data are also expressed in terms of the specification values. The test procedure was excellent. JBJ (10)

Change of Magnetic Resistance of Pure Metals (Zur magnetischen Widerstandsänderung reiner Metalle) M. KOHLER. *Naturwiss.,* Vol. 35, Sept. 23, 1938, p. 630. Original research. All metals except Bi show a relationship between the change of resistance with temperature and the change of resistance with field strength. JZB (10)

Beryllium and Its Alloys. *Metallurgist (Suppl. Engineer),* Aug. 1938, pp. 148-151. Correlated abstract of 17 references, based chiefly on the recent work of Hessenbruch (*Metallwirtschaft,* Vol. 17, May 20. 1938, p. 541). The production of ductile Be seems no nearer to attainment, and to date about the only possible use for pure Be would be in accoustics applications because of the very great velocity of sound travel through the metals. Be-rich alloys are definitely lacking in ductility. The properties and uses of the 2-4% Be-Cu alloys are well known; the next important development may be the successful commercial production of Be-Cu alloys directly by electrolysis. Attempts have been made, with some success, to produce age-hardening Be-Cu alloys in which most of the Be is replaced by Co or Cr. General Electric's Trodalloy No. 1 (2.6% Co, 0.4% Be) and No. 2 (0.4% Cr, 0.1% Be) are typical of such alloys. Hessenbruch refers to a Be-containing tool steel in which the age-hardening effect of Be is superimposed on the quench hardness of C steel, but no details are yet available. VVK + FPP (10)

Nickel-bearing Alloys Used in Petroleum Refining. B. B. MORTON (Intern. Nickel Co., Inc.) *Refiner Natural Gasoline Mfr.,* Vol. 17, June 1938, pp. 306-312. Review. Ni-bearing alloys are widely used in refineries to meet demands imposed by the wide variations of temperature used (—150 to 2,000°F.) and the presence of organic and mineral corrosive agents. The 2.25% Ni steels meet the requirements for vessels and equipment operating at the sub-zero temperatures used during dewaxing of lubricating oils. Monel, Ni, Inconel, and 18-8 are available for use where very low temperatures are encountered. An austenitic cast Fe is one of the most widely used of the Ni-bearing alloys, and finds application in pumps handling naphtha, reflux, acids and bases. The heat-resisting alloys, containing 25-30% Cr, have their physical and oxidation-resisting qualities enhanced by the presence of Ni; these alloys usually contain 12-25% Ni. VVK (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

The Effect of Hydrogen on the Properties of Steel (Ueber die Beeinflussung der Stahleigenschaften durch Wasserstoff) A. LEON. *Montan. Rundschau,* Vol. 30, Aug. 16, 1938 (Section *Stahlbau-Technik*) pp. 1-5. Review. H taken up by molten steel has no effect on the C, S and P in the melt; it decreases the O content, and deoxidation of steel with H should therefore be possible. During and immediately after solidification the steel gives off a large part of the H taken up. Hot working accelerates this. However, even forged pieces of steel may hold considerable quantities of H for a long time. During cooling the liberated H may form gaseous compounds with other elements in the steel, such as C, O and S. Hot working of H-containing steel with less than 0.6% C causes brittleness both at white and red heat. This difficulty can be overcome by cooling followed by reheating and hot working. Ni-Cr steels containing H, with 1% Cr and 3% Ni, show brittleness at red heat, but not at white heat, when forged. They also have a tendency to spalling, which is not overcome by annealing for 1 hr. at 1000° C. Impact strength and resistance to aging of unalloyed steels are lowered by H, but the original impact strength is restored by annealing. The Brinell hardness of a steel is also generally lowered by H. BHS (10a)

Trains Run On Chilled Car Wheels. PAT DWYER (Staff) *Foundry,* Vol. 66, Aug. 1938, pp. 22-24, 62; Sept. 1938, pp. 32-33, 68; Oct. 1938, pp. 32-34, 78, 80. Practical. Considers the history of Griffin Wheel Co. and describes the manufacture of chilled car wheels. Advantages of chilled tread wheels are: (1) Hardness of tread, and maximum service; (2) bearing value unexcelled; (3) rotundity is retained, due to absence of ductility; (4) coefficient of friction between wheel and brake shoe is 20% greater than developed by other types of wheels; (5) durability of brake shoes is 25-100% greater when used on chilled tread wheels; (6) abrasion between chilled Fe flange and steel rail is much less than that of steel flange against steel rail; and (7) factor of safety against derailment is greater. VSP (10a)

The Development of High Strength Steels for Large Steel Structures (Die Entwicklung der hochfesten Stähle für den Grossstahlbau) PAUL HOFF. *Mitt. Kohle u. Eisenforsch.*, Vol. 2, Feb. 1938, pp. 1-82. Unusually comprehensive review. The development of these steels is characterized by the increasingly severe requirements that structural steels must meet. At first, to around 1900, the development of structural steels essentially depended on the steelmaking processes. A basic open hearth and Bessemer steel with about 37 kg./mm.^{2} tensile strength found wide application in steel and bridge construction. After the World War, a steel with higher yield point was sought in Germany. Ni and Cr-Ni structural steels proved uneconomical. In 1924 "Steel 48" with higher C content, permitting 30% higher loads than "Steel 37," was marketed; in 1925 a Si structural steel followed. The development of the high quality structural steels such as "Steel 52," within the last decade is described as a special accomplishment of German metallurgy. The consuming industry has had much to do with this rapid development, particularly the German State Railways. A comparison with the progress of these structural steels in the most important industrial countries is made to show the leading role of Germany in this field. of low alloy high strength structural steels. The yield point is the decisive property of statically loaded structural parts. By using structural steels with high yield point, it is possible to allow higher loads and save weight. The possibilities of weight and cost savings have been further increased by greater application of welding. In many respects the knowledge of the effect of different alloying constituents on the practical behavior of a structure is farther advanced than that of the value of certain mechanical properties and methods of testing. Recently a basic change in methods of evaluating tensile properties has occurred, in that the stress distribution in structures, and testing under actual service conditions are increasingly emphasized. Further progress should be directed toward unification and standardization of composition. A steel economical in use, *i.e.* a steel of high durability will be preferred. The foreign countries followed the German development only partially. Some countries, such as France, adapted the German "Steel 52," while new structural steels of high tensile strength were developed in England and U.S.A. These steels are stated to possess poor welding properties. Recently in Britain and America the development of structural steels of high yield point and good weldability has also been carried on. 240 references. GN (10a)

The Structure and Mechanical Properties of High Test Cast Iron (Ueber Gefügeausbildung und Festigkeitseigenschaften hochwertiger Gusseisensorten) P. BARDENHEUER & W. BRÖHL. *Mitt-Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf*, Vol. 20, No. 11, 1938, pp. 135-146. Original research. The relations between structure and mechanical properties of low-C cast Fe types was investigated on melts of different compositions. Decreasing C and Si content induced a more favorable graphite formation and improved the mechanical properties. A very low C content produced a form of graphite similar to temper carbon. Increase of Mn increased tensile strength in sand castings up to 1.2% Mn in untreated and up to 1.4% Mn in heat-treated samples; further increase in Mn reduced the tensile strength. The tensile strength of chill-mold cast samples decreased, however, with increasing Mn. Brinell hardness increased in all heat-treated samples with increasing Mn content, but decreased in un-heat-treated samples beyond 1.2% Mn. Repeated impact strength showed a maximum at 1.4% Mn. High Si and Mn content (4.8 and 4.5% resp.) with different C contents reduced tensile strength considerably, irrespective of heat-treatment and casting method, while hardness and brittleness increased, except melts with low C which showed good mechanical properties. Solidification of an inoculant-free melt produced the pseudoeutectic with its unfavorable effect on mechanical properties. Inoculation of a low C melt with soda and carbon produced a structure of pearlite and temper carbon, but had less or no effect with high C content. Temper carbon is the most favorable form of graphite for mechanical properties; it is produced in all white chill-mold castings by subsequent heat-treatment, and in sandcastings only for C contents below 2%. Annealing is of advantage for medium-C contents while for low-C quenching in oil with subsequent annealing at high temperature is advisable. 18 references. Ha (10a)

Centrifugally Cast Bushings (Schleudergussbüchsen) W. A. GEISLER & H. JUNGBLUTH. *Tech. Mitt. Krupp. Tech. Ber.*, Vol. 6, Aug. 1938, pp. 96-101. General review of present wear-resistant materials and methods of manufacturing them for linings of cylinders and bushings with and without water-cooling. Ordinary cast Fe or Fe with a few tenths of 1% Cr of very fine grain and a Brinell hardness of at least 260 is being produced by centrifugal casting. Martensitic bushings are heated to 850° C., quenched in oil and drawn; their hardness is 400-500 Brinell. Alloy cast Fe with up to 0.5% Cr and about 1% Mo is used for Diesel engines. Cast Fe with 1% Cr and 1% Al is particularly suitable for nitrided bushings, giving 700-900 Vickers on the surface. 13 references. Ha (10a)

Effect of Arsenic on the Properties of Steel and Cast Iron (Einfluss des Arsens auf die Eigenschaften von Stahl und Gusseisen) F. KÖRBER & G. HAUPT. *Arch. Eisenhüttenw.*, Vol. 12, Aug. 1938, pp. 81-89. Review. In steel static tensile tests indicate As up to 0.3% is not injurious. The tensile strength, with up to 2% As increases, then decreases. Hardness is little affected by up to 0.8% As. The impact properties are lowered. Stead reported the bend properties of steel with up to 1% As to be satisfactory, but others found them to be lowered by 0.2% As. Some found about 0.25% As to injure the hot rolling properties, while others noted no such effect up to 4% As. Arsenic injures high speed steel. Above 0.1%, As impairs weldability. As improves corrosion resistance. It improves transformer steel by lowering the Watt loss. In cast Fe, As lowers the tensile strength, increases the hardness, lowers the transverse bending strength when above 1% As is present, particularly when the P and S are high. Up to 0.3% As the wear resistance is improved —beyond that it is injured. As improves corrosion resistance against both acids and alkalies. 51 references. SE (10a)

Effect of Arsenic on the Properties of Steel (Einfluss des Arsens auf die Stahleigenschaften) E. HOUDREMONT, H. BENNEK, H. NEUMEISTER. *Arch. Eisenhüttenw.*, Vol. 12, Aug. 1938, pp. 91-101. Original research. Up to 1% As was added to a series of C, Cr-Ni, and Cr-Mo steel melts made in a 25 kg. induction furnace. Up to 0.25% As was also added in the ladle of full size basic Bessemer and O. H. steel melts. Pipe and blowholes in the ingot were not affected by As. Arsenic segregates about the same as P in effervescing steel and C, P, and S in killed steel. The hot working properties were unaffected by As up to 1%. Arsenic in general raised the tensile properties and lowered the toughness, particularly in harder steels. No injurious effect of As on cold deformability was noted. Up to 0.25% As did not injure the weldability of sheet steel. Above that the weldability of gas welds was seriously injured. The tensile strength of gas and electric welds of sheet with up to 0.25% As was not lowered. Arsenic injured forge welding more than it did electric welding. Up to 0.2% As did not lower the hardness of tool steel; above that it did. The temperature of the α-γ transformation is raised by As. The toughness of harder heat-treated steels is appreciably lowered by even small amounts of As. If As were to be used as an addition element, it would gradually build up in the scrap, as Cu and Ni do. SE (10a)

The Exceptional Wearing Properties of Early Steel Rails. C. J. ALLEN. *Iron & Coal Trades Rev.*, Vol. 137, Sept. 23, 1938, pp. 467-468; Sept. 30, 1938, pp. 507-508. The fact that steel rails made in the earliest days of steel making were superior, and sometimes in use for 40 years, is commented upon. They were made of acid Bessemer steel of 0.32-0.45% C, 0.2 and, in other years, 0.056-0.093% Si, 0.71-1.14% Mn, 0.05-0.072% P and 0.075-0.122% S; they were rolled and finished at lower temperatures than is practical now. Brinell tests on the running surfaces showed much greater hardness than on web and foot, showing that the surface had hardened considerably under traffic. In spite of different C contents, the hardness of the running surface in 5 rails was the same, showing that the low C rails had greater capacity to harden than those with higher C; this is ascribed to work-hardening rather than age- or skin-hardening. In the long years of service the rails were hardened and therefore can withstand modern railroad service. This fact might account for the less satisfactory behavior of modern steel rails, although made under much more uniform and exacting conditions, as they are at once subject to heavy traffic and can not gradually "age" under lighter traffic conditions. The change of British standards for rails is compared from 1909 to 1935. The average composition now required is 0.55-0.61% C, 0.125-0.132% Si, 0.70-1.05% Mn, 0.04% P and 0.038-0.05% S, with a breaking strength of 52 ton/in.^{2}, elongation 13.5-18% and a reduction of area of 17-29%. Present manufacturing conditions and testing methods are described. Ha (10a)

Cast Crank- and Camshafts (Gegossene Kurbel- und Nockenwellen) H. JUNGBLUTH. *Tech. Mitt. Krupp, Tech. Ber.*, Vol. 6, Aug. 1938, pp. 88-96. Review. The good practical behavior of cast crankshafts and cams is believed due to the embedded graphite, which reduces the elasticity modulus and notch-sensitivity and increases damping properties. Comparisons with steel and malleable Fe are made, and present methods of manufacturing and the changes of structure by local hardening are described. Crankshafts are cast of pearlitic, sometimes slightly alloyed Fe, heat treated martensitic cast Fe, or of a material similar to malleable Fe. Ha (10a)

The Properties and Uses of Chilled Iron. S. C. MASSARI (Assoc. of Manufacturers of Chilled Car Wheels) *Am. Soc. Testing Materials*, Preprint, June 1938, 16 pp. Review. This paper describes the basic metallurgy of chilled Fe, its technique of production and metallographic nature. Recent developments in the heat treatment of chilled Fe with the subsequent improvement in physical properties and metallographic structure are described. The effect of alloying elements in increasing or decreasing depth of chill is discussed. VVK (10a)

Change of the Modulus of Elasticity and Damping of an Iron-nickel Alloy at the γ-α Transformation (Aenderung von Elastizitätsmodul und Dämpfung einer Eisen-Nickel-Legierung bei der γ-α Umwandlung) E. SCHEIL & W. THIELE. *Arch. Eisenhüttenw.*, Vol. 12, Aug. 1938, pp. 103-105. Original research. The apparatus for determining the modulus of elasticity and damping properties of a thin wire about 150 mm. long is described. The alloy used contained 22.4% Ni, the γ-α transformation occurring at about 135° C. The wire is oscillated in torsion and as it is cooled through the γ-α transformation the vibrations are rapidly damped. The modulus of elasticity also falls sharply during the transformation. SE (10a)

Some Autarchic Trends with Respect to Steels (Alcuni indirizzi autarchici nel campo degli acciai) T. NATALE. *Ind. meccanica*, Vol. 20, Aug. 1938, pp. 663-666. In order to be independent (from the Italian economic standpoint) of foreign metals, an examination was made as to how far Ni in steels can be replaced by W or other elements without impairing, in any way, their mechanical properties. A list of alloy steels commonly used at present in Italy, with their properties, is given. For stamping and other dies, a series of steels with 4.4% Cr and varying amounts of 6-25% W, 0-4% Mo and 1-2.5% V are recommended. Ha (10a)

Characteristic Values of High-grade Cast-iron (Gütewerte von hochwertigem Grauguss) K. KNEHANS. *Tech. Mitt. Krupp, Tech. Ber.*, Vol. 6, Aug. 1938, pp. 102-108. Results of tests of mechanical properties for some German standard cast irons are described. Tensile strengths of 54,000-64,000 lbs./in.^{2}, bending strengths of 78,000-91,000 lbs./in.^{2} with 13-15 mm. deflection, Brinell hardness of 220-250, and tensile strength of 18,000-23,000 lbs./in.^{2} at 600° C. Bending-fatigue and impact tests were also made. Ha (10a)

Pilger Mill Mandrels Not Containing Imported Alloying Elements. I. ROZENBLIT. *Stal*, Vol. 8, Jan. 1938, pp. 52-59. In Russian. Practical. A study of steels containing neither Ni nor Mo, which Russia must import, showed that steel containing 0.29% C, 0.95% Mn, 0.94% Si and 1.0% Cr was superior in service to the steel previously used which contained 0.35-0.55% C, 0.4-0.7% Mn, 0.20-0.45% Si, 0.4-0.8% Cr, 1.3-2.2% Ni and 0.2-0.4% Mo. HWR (10a)

Stainless Steel Wire. J. K. FINDLEY (Allegheny Ludlum Steel Corp.) *Wire & Wire Prod.*, Vol. 13, Oct. 1938, pp. 517-519. Review. Stainless steel wire is employed at present in the paper and chemical industries, woven wire conveyor belts, for springs operating in corrosive atmospheres, rope on ocean-going yachts, aircraft, radio antennae and many similar purposes. Methods of manufacture, processing of the wire, and selection of proper material are discussed in general. Ha (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Recent Progress in the Field of Rolled Aluminum Alloys (Ueber einige neuere Fortschritte auf dem Gebiete der Aluminium-Walzlegierungen) P. BRENNER. *Aluminium*, Vol. 20, Sept. 1938, pp. 606-620. Review. The production of Al ingots that are sounder and contain fewer gas inclusions, is made possible by the Züblin method, which uses a mold, with a vertical slit, through which the liquid metal flows in a channel. The method is claimed to reduce the possibility of liquid jets carrying along impurities and absorbing gases; segregations are avoided. An Al-Cu-Mg block showed a much more uniform Cu distribution and finer grain; the differences in Cu content at different places were not greater than 0.7%. These ingots are good enough to be used directly for rolling or forging without first remelting the ingot. Experiments with Al-Mg alloys have shown that these alloys are still inferior to Al-Cu-Mg with regard to intercrystalline corrosion, and that, particularly for airplane parts, the danger of harmful precipitation due to temperature differences is present. Diagrams show the influence of heat-treatment on the corrosion resistance, and microphotographs show the structural changes. 15 references. Ha (10b)

The Tensile Properties of a Series of White-metal Bearing Alloys at Elevated Temperatures. H. GREENWOOD. *Tech. Pub. Intern. Tin Research Development Council*, Ser. A., No. 58, Aug. 1938. Original research. Tensile properties of typical Sn-base bearing alloys were examined at temperatures up to 175° C., and the effects of Cd and Pb additions were noted. As the temperature rises, maximum stress and yield fall fairly uniformly, while elongation and area reduction increase. Cd markedly increases tensile strength when cold but helps little when the alloys are hot, *e.g.* addition of 1% Cd increases tensile strength 50% at room temperature but only 10% at 175° C. Addition of 4% Pb may be slightly beneficial when cold but decreases the tensile strength at elevated temperatures. BWG (10b)

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Silver Membranes. HAROLD J. READ & MARTIN KILPATRICK (Univ. Penn.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 17, 23 pp. Original research. The Ag membranes were prepared by heating a thin sheet of Zn-Ag alloy (0.013 cm. thick) in a vacuum (0.2 mm. of Hg) at a temperature 650-850° C. for 2-20 hours. Practically all the Zn distilled out of the alloy, leaving behind a porous sheet of Ag. The permeability of the Ag was determined by measuring the rate of diffusion of gases through a thin sheet of the material. The membranes were more permeable to gases of low molecular weight. Erratic results were obtained with easily condensable gases, such as CO_2 or water vapor. A number of factors influenced the permeability of the membranes. A Ag-Zn alloy containing 13% Zn did not yield a membrane permeable to gases, but an alloy containing over 20% Zn was satisfactory. The Zn content could not be increased above 28.5% because the resulting alloy was too brittle to roll into the thin sheets required for the preparation of membranes. An increase in the time or the temperature of heating increased the permeability, and an increase in thickness of sheet decreased the permeability of the membrane. Subjecting the alloy to a sudden heating produced a membrane with a higher porosity than by gradually raising to temperature. Photomicrographs of the membranes were studied but yielded no relation between surface appearance and permeability. By calculation, the average radius of the pores was found to be 10^{-4} cm. and the average number of pores per cm.^{2} was several thousand. AB (10b)

Alloys with Low Copper Content (Les Alliages à Faible Teneur en Cuivre) L. GUILLET. *Cuivre et Laiton*, Vol. 11, Sept. 30, 1938, pp. 415-416. Review. Antifriction metals, Zn alloys and Al alloys with less than 15% Cu are discussed and their importance explained. Cu_3Sn forms distinct microscopic needles and is used, as is $CuAl_2$ (with 12% Cu), for bearing bushings. The most-used Zn alloy is 92% Zn, 3% Cu, and 4% Al; it has a tensile strength of 50,000 lbs./in.^{2} and elongation of 1-5%. It should be cast in chill molds to avoid a transformation that takes place with slight contraction. The Zn used should be very pure, and the addition of 0.05% Mg effects stabilization in 4-5 weeks. The various known binary Al alloys with Cu, duralumin and alloy V, are briefly described. An addition of Ti facilitates thermal treatment and produces fine grain. The Al alloy with 4.5% Cu, 0.5% Ti is treated by heating for 5 hr. at 525° C. and "tempering" for 9 hr. at 150°; it has a tensile strength of 43,000 lbs./in.^{2} and an elongation of 5%. Ha (10b)

Non-ferrous Metals in Shipbuilding. Reciprocating, Turbine and Oil Engine Construction. J. W. DONALDSON. *Metal Ind., London,* Vol. 53, Aug. 26, 1938, pp. 195-198; Sept. 2, 1938, pp. 231-233. Review. Recent developments in marine engines require better materials of construction. Although steel is used principally, the range of non-ferrous alloys has been greatly extended. Marine engineering uses non-ferrous alloys principally for their corrosion resistant properties, although recently Al alloys have found application because of the weight saving. Casting alloys include gunmetal, P-bronze, brass, Cu-Ni, Al, and bearing alloys. Wrought alloys of Cu, brass and Cu-Ni are used chiefly in the form of tubes, sheets, and bars. Admiralty gunmetal of 88% Cu, 10% Sn and 2% Zn is in common use. When exposed to steam the Sn must not exceed 10%, but for simple air pressure 12% Sn alloy is used. Hard bearings require an alloy of 82% Cu and 18% Sn. Where salt water conditions do not require hardness, a 93% Cu, 4% Sn, 2% Zn and 1% Pb alloy is used. For withstanding severe corrosion Monel or Ni bronze is used. Cast Al alloys consist essentially of Al and Si. White metal, Cu-Pb, Cd-Ni and Pb-base bearing alloys have recently found considerable application. Cu-Ag-Zn alloys are finding limited application in turbines. Boiler construction is principally ferrous. In maritime reciprocating engines and auxiliaries, non-ferrous alloys are chiefly used for bearings. Monel, stainless steel and alloy steels have replaced 70/30 brass, P-bronze and Cu-Mn for turbine blading. Gunmetal is used for numerous parts and fitting of turbines. Non-ferrous alloys find considerable application in marine oil engines in bearing fittings, pistons, starters, cooling systems, air compressors, etc. Corrosion is one of the most serious problems in marine engineering, and is a special problem in condenser tubes. It has been established that the best protection is afforded by means of strong adherent films, either self forming or artificial. Alloys of 70/30 Cu-Ni and Al brass possess film forming properties and have almost entirely replaced other alloys for this purpose. Boiler and steam line valves have spindles of rolled naval or high tensile brass and seats of Admiralty gunmetal. In turbine work Monel metal or Ni-bronze seats are used with naval or high tensile brass or alloy steel spindles. Horizontal or vertical centrifugal pumps and reciprocating pumps use considerable gunmetal, special brasses, Cu-Ni alloys and bearing metals. In small craft and fast motor boats, shafting of steel has been replaced by non-ferrous alloys. Propellers use special high tensile brass. See also *Metals and Alloys,* Vol. 9, July 1938, p. MA 454R/2. RWB (10b)

The Effect of Cold-work and Annealing on the Hardness of Some Sn-Sb, Sn-Sb-Cu and Sn-Sb-Ag Alloys. R. E. LEYMAN. *Tech. Pub. Intern. Tin Research Development Council,* Ser. A, No. 53, June 1937. Original research. Mechanical properties of pewter were studied by hardness tests on Sn-base alloys containing 3-7% Sb with or without addition of 0.5-3% Cu or Ag. All alloys at first hardened on slight or moderate cold rolling, but after 20-40% area reduction progressive softening occurred, until a hardness equal or less than that as cast was reached after about 80% cold reduction. Softening on severe working was most pronounced with highest percentage of alloying elements. Annealing after rolling caused further softening in most cases but the alloys containing 3% Cu or 0.5-3% Ag recovered part of the hardness lost on severe working. Quenching-aging treatments were without permanent effect although the Sn-Sb-Ag alloys showed an appreciable hardness increase on quenching, which was lost in 100 days at room temperature, or more rapidly at higher temperatures. BWG (10b)

The Properties of High Purity Aluminum. C. S. TAYLOR, L. A. WILLEY, DANA W. SMITH & JUNIUS D. EDWARDS (Aluminum Res. Lab.) *Metals and Alloys,* Vol. 9, Aug. 1938, pp. 189-192. Reports original work on the physical constants of Al of 99.996% purity. The methods for the various determinations are given and the following results were obtained for certain properties: Melting point, 660.24° C. Thermal expansion $L_t = L_o [1 + (23.22t + 0.00467t^2 + 0.0000078t^3) 10^{-6}]$ where L_t is length at temperature t and L_o is length at 0° C. Lattice parameter a = 4.0415 A.U. Density at 20° C., 2.6953 gm./cc. (calculated from lattice parameter). Density (hydrostatic weighing) at 20° C., 2.6989 gm./cc. Volume resistivity in microhms-cm. at 20° C. → 2.6548. Volume percent conductivity (Internat. annealed Cu = 100%), 64.94%. Mass resistivity in ohms (meter, gram) at 20° C., 0.07165. Mass per cent conductivity (Cu = 100%) → 213.92%. Mechanical properties and radiation characteristics are also reported. WLC (10b)

Read "TRENDS" . . .

on page MA70 for the latest news, its significance, and what it means to metallurgical engineering, as seen by E. F. Cone.

Mechanical Properties of Some White Bearing Metals and Other Tin-base Alloys at Various Temperatures. C. S. HORNER & H. PLUMMER. *Tech. Pub. Intern. Tin Research Development Council,* Ser. A, No. 57, Aug. 1937. Original research. Tensile and hardness tests were made at various temperatures on a series of typical Sn-base bearing metals, with and without the addition of varying amounts of Cd. Strength and hardness increased with additions of up to 3% Cd. Strength increases with over 3% Cd were offset by loss of ductility. The extra strength due to Cd was retained at elevated temperatures, although all alloys lost strength with temperature increase. Elimination of Sb showed no advantages and many disadvantages. Strength values were strongly influenced by rate of strain; this rate could be increased with temperature increase, but at any given temperature a critical speed of testing could be found that would give maximum strength values. BWG (10b)

The Effect of Iron on Magnesium. W. R. D. JONES. *Metallurgist (Suppl. Engineer)* Aug. 1938, pp. 157-158. Original research. Molten Mg will not dissolve Fe to any appreciable extent. Fe-Mg alloys up to 0.24% Fe were made by melting Fe sawings mixed with Mg sawings in a thick-walled capsule of Mg metal that was placed in the molten Mg. Flux used was magnesium chloride mixed with magnesium fluoride. Table gives mechanical properties of alloys. In the cast state, physical properties are improved somewhat by small amounts of Fe, but with more than 0.14% the values are diminished. Fe decreases the values for the mechanical properties of rolled bars of Mg. Effect of small amounts of Fe on Mg is not disadvantageous. Fe does not decrease the physical properties until present to an amount definitely much in excess of that which Mg or its alloys can pick up during normal melting operations. VVK (10b)

Fusible Alloys Containing Tin. E. J. DANIELS. *Tech. Pub. Intern. Tin Research Development Council,* Ser. B, No. 5, Aug. 1937, 24 pp. Comprehensive description. The relation of composition to melting point, structure and physical properties of fusible metals is described. It is important to cast the alloys under controlled conditions to get dependable results in regard to plasticity and creep. Many of these alloys expand on solidifying. Methods of avoiding corrosion troubles are given. Applications include sprinkler plugs, boiler plugs, fusible links, seals for glass apparatus, patterns for molding and electroplating, tube bending, for tempering baths and die mounting. 117 references. BWG (10b)

Investigations on Magnetically Oriented Bismuth (Untersuchungen an magnetisch orientiertem Wismut) A. ALTMA. *Ann. Physik,* Series 5, Vol. 32, July 1938, pp. 489-506. Research. If Bi powder is allowed to fall through a magnetic field, the particles orient themselves with the principal crystallographic axis in the direction of the magnetic field. Such powder column can be compressed to a briquette that then behaves like a single crystal in the magnetic field and shows the characteristic anisotropy of the Bi crystal structure. Results of measurements of physical properties are given. Ha (10b)

New and Growing Uses for Aluminum. J. O. CHESLEY (Aluminum Co. of America) *Mining and Met.,* Vol. 19, Oct. 1938, pp. 431-435. Practical discussion of the application of Al. VSP (10b)

10c. Effect of Temperature

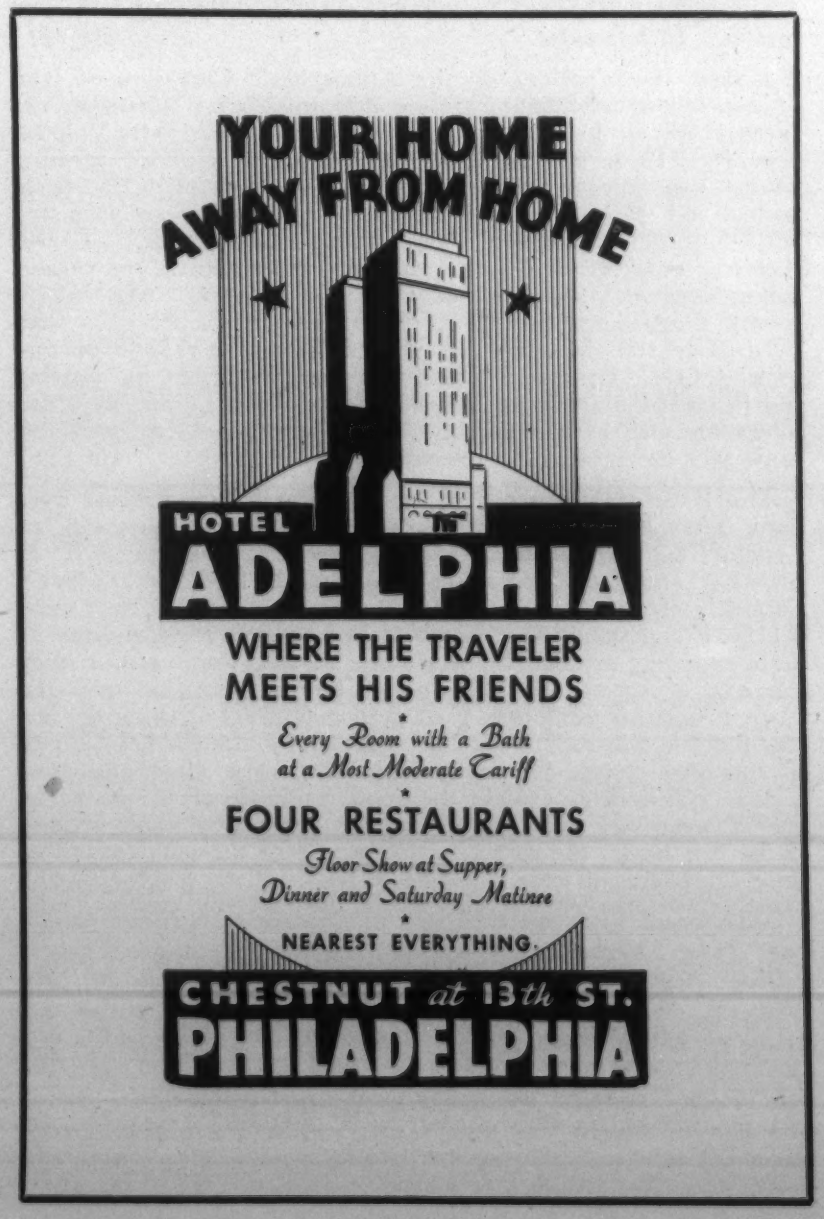
H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation of the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Report of Joint Research Committee on Effect of Temperature on the Properties of Metals. *Am. Soc. Testing Materials, Preprint,* June 1938, 70 pp. Progress report with data as reported in the following papers: **Progress Report on Creep Tests of Tubular Members Subjected to Internal Pressure.** F. H. NORTON. 3 pp. Some data reported but are not as yet complete. Tests are on C-Mo steel at 800 and 1050° F. and on 5 Cr, 0.5 Mo steel at 1200° F. However, it is interesting to note that under certain conditions a pressure vessel may decrease in length during service and under other conditions may increase in length substantially at the same rate as the diameter increases. **Report on Long-time Creep Test of 0.35 Per Cent Carbon Steel (K20).** HOWARD C. CROSS & J. S. LOWTHER. 8 pp. The long-time creep test on this annealed 0.35% C steel at 850° F. indicates extrapolation from the 2000 hr. period to be conservative, as compared with the actual deformation measured over 20,000 hr. An approximately constant rate of deformation was obtained between about 4000 and 20,342 hr. Experiments on effect of temperature on the creep rate while

loaded to 7500 lb./sq. in. indicate a change of creep rate of 5-1 for temperature change 50° F. below or above 850° F. Tensile and impact tests on the specimen 25B5 after creep test indicate very small and unimportant changes in physical properties to have occurred due to the time at temperature under load. Examination of the structure indicates little or no change from that shown for the material as heat treated and before creep test. This very stable structure no doubt accounts for the long period of constant creep rate and unchanged physical properties. **Report Covering Creep Tests on 0.35 Per Cent Carbon Steel (K20) at 850° F. Under Stress of 7500 Lb. Per Sq. In.** C. L. CLARK. 10 pp. The data submitted permit the following conclusions: The K20 steel used was of at least as high a degree of uniformity as it is possible to secure commercially under the present knowledge of melting practice and the results obtained from the tests at 850° F. are in very good agreement when the comparisons are based on creep strength. The relative strengths range from 1.00 to 1.074. The agreement in creep strength is of the same order of magnitude as that found to exist previously in the elevated temperature tensile strength values. If the same results are compared on the basis of creep rate rather than creep strength, then appreciable differences do exist which cannot be directly related to the type of equipment used, the size of specimen, the type of extensometer, the temperature uniformity of the specimen or to the electrical characteristics of the furnace. The results, therefore, indicate that the creep rate and deformation characteristics are too sensitive an index of strength to permit exact duplication either in different laboratories or in duplicate tests in the same laboratory. The results obtained from certain of the tests at temperatures other than 850° F. are not in as good agreement either among themselves or with the results obtained from the 850° F. tests. These apparent discrepancies may be due either to slight non-uniformities in the steel or to as yet unknown inconsistencies in the testing technique. **Report on Acceptability Tests for High Temperature Characteristics.** A. E. WHITE & C. L. CLARK. 5 pp. The stress-rupture test consists of fracturing a series of specimens at each temperature under fixed loads so adjusted that the resulting fracture times vary from a few minutes up to 15 hrs. When the stresses and corresponding fracture times are plotted to logarithmic coordinates, a straight-line relationship exists, provided the material possesses a sufficient degree of structural and surface stability under the given test conditions. It is thus possible to obtain the stresses corresponding to definite fracture times. Data are reported for K20 (.35% C) steel, SAE 1040, .5% Mo steel and 4-6% Cr-Mo steel. **Progress Report on Study of Effects of Manufacturing Variables on the Creep Resistance of Steels.** H. C. CROSS & J. G. LOWTHER. 23 pp. This progress report shows results of creep tests at 850° F. on 12 plain C steels with known Al additions and one C-V steel. Some of the steels were tested at 750° and 950° F. Several steels were intentionally coarsened by proper heat treatments to provide material for comparison of the relative creep resistance of fine-grained and coarse-grained materials. The data indicate decided superiority of creep resistance at 750°, 850° and 950° F. for coarse-grained plain C steel over fine-grained plain C steel of the same chemical composition. Several relaxation tests on K20 also indicate superiority for coarsened K20 steel. The C-V steel, which showed superior creep resistance to plain C steel as fine-grained, was not improved greatly by coarsening. **Report Covering Information on Steels for Tubular Creep Tests and Other Test Work of the Joint Committee.** H. J. KERR, J. B. ROMER & H. D. NEWELL. 9 pp. Manufacturing data and micrographs of structure. **Proposed Revised Tentative Method of Test for Long-time (Creep) High-temperature Tension Tests of Metallic Materials.** 6 pp. Specification issued 1935, revised, 1937, 1938. VVK (10c)

Actual Grain Size Related to Creep Strength of Steels at Elevated Temperatures. S. H. WEAVER (Gen. Elec. Co.) *Am. Soc. Testing Materials,* Preprint, June 1938. 6 pp. Original research. A collection of 32 creep tests, all made at the same temperature of 840° F. and all on the same analysis within the commercial limits of S.A.E. 4330, a Ni-Cr-Mo steel, whose creep stresses (for a constant creep rate of 1% per 100,000 hr.) vary from 10,800 to 40,200 lbs./sq. in., was analyzed statistically. Correlation of the creep strength with the actual size of the existing carbide grain (using only those steels with uniform microstructure) showed that there was an optimum grain size for the maximum creep strength; a larger or smaller grain than the optimum value gave a decreasing creep strength. For this particular steel and temperature: (a) Changing the grain size can vary the creep strength by 21,000 lb./sq. in. (b) The structure within the grain can change the creep strength by 4500 lb./sq. in. (c) Ferritic banding in the visible mechanical form can lower the creep strength up to 4300 lbs./sq. in., while in the "masked" or distributed form the effect of banding is negligible. [The method of determination of the grain size is questionable. The paper does not contain sufficient proof of the decreasing creep strength with grain sizes larger than No. 6.—H.C.C.] VVK (10c)



11 · CORROSION AND WEAR

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Steels for Use in the Petroleum Industry (Stähle für Treibstoffgewinnungsanlagen) F. K. NAUMANN. *Tech. Mitt. Krupp, Tech. Ber.,* Vol. 6, Aug. 1938, pp. 77-87. Comprehensive research. The behavior of ordinary and alloy steels in cracking and hydrogenization processes at high temperatures and pressures up to 1000 atm., especially in contact with H_2 and H_2S was experimentally investigated. Unalloyed steels with various C contents are attacked by H even at 360° C. at 300 atm. after 300 hr. Increasing pressure shifts the beginning of attack to lower temperatures. Ni steels have scarcely better resistance against H_2; the attack begins also at 350°-400°. Cr-Ni steels show a better behavior if C is low. Cr increases resistance to H_2 attack, especially for Cr contents higher than 3%; this is ascribed to the existence of the carbide Cr_7C_3. Cr-Ni steels with higher C (0.25 and more) are less resistant, since the carbide $(FeCr)_3C$ is present. All high Cr and Cr-Ni steels show excellent H_2 resistance, even with high C content; a steel of 13.6% Cr and 0.35% C, and another of 16.6% Cr and 0.90% C, were still good at 600° C. Austenitic Cr-Ni alloys withstood 750° C. without fracture after 300 hr. W and Mo steels have even better resistance than Cr steels. Steels with 3-6% Cr also possess high resistance to H_2S. V-steels are resistant to H_2 only if the ratio V : C is at least 5.7 : 1, for below this ratio not only the resistant V_4C_3 occurs but also Fe_3C, which is easily attacked. Similarly, in Ti steels, about 4 times as much Ti as C must be present to be resistant to H_2. Neither V nor Ti steels are resistant to H_2S and furthermore are not easily forged in large masses. 10 references. Ha (11)

Recent Investigations on the Atmospheric Corrosion of Iron (Neue Untersuchungen über die atmosphärische Korrosion des Eisens) W. H. J. VERNON. *Korrosion u. Metallschutz,* Vol. 14, June/July 1938, pp. 213-220. Review of the author's previous work. Experiments with commercial Fe of about 0.1% C in normal and saturated atmospheres, some pure and some inoculated with the usual air-borne particles, are described in detail. Curves show the progress of loss of weight of the samples in the various atmospheres and the effect of CO, CO_2 and SO_2. CO_2 has in general a retarding effect on corrosion, even if SO_2 is present with CO_2; after 100 days the loss with CO_2 was only 50% of that without CO_2. Foreign particles in air always hasten the starting and increase the attack of corrosion, especially if specifically active substances such as ammonium sulphate or other dissociated inorganic salts are present. 7 references. Ha (11)

The Rate of Corrosion of Steel in Rural Atmospheres over Long Time Periods (Die Rostungsgeschwindigkeit von Stahl an Landluft im Verlauf sehr langer Zeiten) K. DAEVES & K. F. MEWES. *Stahl u. Eisen,* Vol. 58, Aug. 4, 1938, pp. 841-842. Original research. Rails of 0.25-0.40% C Bessemer steel with 0.15% P and 0.2-0.3% Cu, which had been in service about 27 years and were exposed to the weather 60 yrs., were used to study the rate of corrosion. The average rate of corrosion over the 60-yr. period for these rails was 20-40 g./m.²/yr. During the last year the rate was only 2-3 g./m.²/yr. This indicated that the rate of corrosion keeps decreasing with time even after prolonged periods. This helps explain the good resistance of old Fe. The rate of wear was also determined, this being very small because of the low loads; the coarse microstructure of the rails seemed to favor a low rate of wear. SE (11)

Behavior of Light-metal Alloys in Contact with Moist Acetylene (Das Verhalten von Leichtmetall-Legierungen gegen feuchtes Acetylen) H. LICHTENBERG. *Aluminium,* Vol. 20, July 1938, pp. 465-466. Original research. Al of 99.5% purity and Al alloys, with different surface treatments, were exposed for 300 days to acetylene in an acetylene generator. Except for discoloration in some samples, no change of the surfaces could be noted. The loss in weight was very small; in the worst case it corresponded to a reduction of thickness of less than 0.13 mm. per year. Tests are described in detail. Ha (11)

Atmospheric Corrosion of Non-ferrous Metals and Alloys. Report of the Subcommittee VI of A.S.T.M. Committee B-3 on Corrosion of Non-ferrous Metals and Alloys. W. H. FINKELDEY. *Am. Soc. Testing Materials,* Preprint, June 1938, 23 pp. This report is the third (6-yr.) series of tests made on 24 non-ferrous metals and alloys exposed in 1931 to various atmospheres at 9 test locations. No conclusions are drawn, but the following observations are made: Substantial losses in tensile strength or percentage elongation, or both, have occurred at most of the industrial and sea coast locations for the 3 samples of Zn, commercial Al, some Al alloys, Mn-bronze, 70-30 brass and Sn. With the exception of the 70-30 brass and Mn-bronze, the losses of tensile properties of the coppers and other Cu alloys at all test locations are so small as to be of little significance at this time. The same is true for Ni and the high Ni-Cu alloys, as well as Pb and the Pb-Sb alloy. In the rural locations the losses of tensile properties are negligible for all materials except Sn. Loss in tensile properties has apparently had no relation to change in weight on uncleaned specimens, irrespective of the type of atmosphere, the character of the corrosive attack or the kind of metal or alloy. This is to be expected in the case of those metals subject to serious pitting, an intercrystalline type of corrosion, alloys susceptible to dezincification, or where corrosion products are particularly adherent. Tables of data are given. For previous work, see also *Metals and Alloys,* Vol. 7, May 1936, p. MA 262R/7. VVK (11)

Comparative Corrosion Tests with Commercial Wrought Iron and Low Alloy Steel in Seawater and in the Laboratory (Vergleichende Korrosionsprüfungen mit handelsüblichem Flusseisen und niedrig legiertem Stahl im Meer und im Laboratorium) A. PORTEVIN & E. HERZOG. *Korrosion u. Metallschutz,* Vol. 14, June/July 1938, pp. 205-213. Original research. The tests were made with a salt spray in the laboratory and by immersion in the ocean. Although in general a qualitative agreement for the average velocity of corrosion (as loss of weight) was found the laboratory tests did not exactly agree and showed less loss of weight than in the seawater. A steel with 3% Cr + Al showed a 1/8 to 1/3 lower weight loss in seawater than in the laboratory test. The corrosive attack depends to a large degree on surface condition. 7 references. Ha (11)

Boiler Feedwater Studies, Report of Joint Research Committee. C. H. FELLOWS. *Am. Soc. Testing Materials,* Preprint, June 1938, 3 pp. Progress report. Laboratory work indicates that lignins successfully prevent the development of intercrystalline cracking in steel specimens stressed under a static load or in a reversed torsional load. Work planned includes study of the effects of chlorides on embrittlement, further work on lignin and concentration of boiler water salines in capillary spaces of boilers, study of tendency of actual boiler water to cause embrittlement and a study of the occurrence or possibilities of occurrence of caustic embrittlement in boilers operating above 500-lb. pressure. VVK (11)

The Parabolic Law of Oxidation. G. D. PRESTON. *Phil. Mag.,* Vol. 25, July 1938, pp. 65-82. Theoretical discussion. The law as expressed by $w^2 = 2kt$, where w is the weight of O combined on unit area of the metal surface after time t (initial weight being zero), and k is a parameter, is discussed theoretically with regard to practical applications. The parameter k is not a constant but must be considered as proportional to pressure. This would explain an increase of oxidation as calculated from the law, and also observed to hold for metals under stress, which oxidize more rapidly than those in an unstressed state. Ha (11)

The Prospects of Aluminum as Corrosion Protection of Iron (Die Aussichten des Aluminiums für den Korrosionsschutz des Eisens) *Tech. Blätter,* Vol. 28, May 1, 1938, p. 262. See *Metals and Alloys,* Vol. 9, Oct. 1938, p. MA 612L/7. It is pointed out that Al may well be used in dairies if the necessary precautions such as cleaning by non-alkaline solutions and application of special cooling agents are observed. Numerous investigations have shown that Al and its alloys are stable against almost all dairy products. GN (11)

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Corrosion of Steels Containing Tin. *Metallurgist (Suppl. Engineer)* Aug. 1938, pp. 151-152. Correlated abstract of 5 references. The existence of Sn as a constituent of steel scrap makes a knowledge of its influence on the properties of steel of vital importance. Work done many years ago showed that over 0.06% Sn impaired the ductility of rail steel, but that in steels of lower-C content, a tendency to red-shortness when Sn exceeded 0.15% was the only noticeable ill effect. Shock resistance of mild steel is reduced by over 0.2% Sn. Recently Daeves has studied the effect of Sn on the corrosion of steels. Careful analysis of his experiments shows that Sn has no deleterious effect on resistance to atmospheric corrosion, but such benefit as it could confer may be obtained with Cu, without the tendency to red-shortness and lowered ductility associated with Sn. This applies equally to steels with and without Cu. VVK + FPP (11)

The Resistance of Metals to Hydrochloric Acid (Einiges über die Beständigkeit metallischer Werkstoffe gegenüber Chlorwasserstoff) E. RABALD. *Chem. Fabrik,* Vol. 11, June 8, 1938, pp. 293-299. Review. An examination of the resistance of elements and commercial alloys to HCl and its salts. Corrosion resistance, strength and fabrication properties of Ag, Pb, Cu, Sb, Ni and Fe alloys in aqueous HCl solutions are given. The effects of HCl in the gaseous state and in the liquid state, as pure HCl or as non-aqueous solutions or aqueous solutions with corrosion promoting or inhibiting additions, are also considered. PCR (11)

Causes, Consequences and Prevention of Corrosion of Mine Pumps (Korrosionserscheinungen an Bergwerkspumpen. Ursachen, Folgen und Beseitigung) *Tech. Blätter,* Vol. 28, May 22, 1938, pp. 301-303. Discusses corrosion due to acidic water, plugging of pipe lines; as corrosion resistant material for the races a synthetic resin product was used. Use of a special acid resistant bronze for various important pump parts, and application of steel pipes coated with bitumen are described. GN (11)

The Corrosion-time Relationship for Underground Pipes: A Theory. NORMAN L. HOFF (Southern Calif. Gas Co.) *Gas Age,* Vol. 81, May 12, 1938, pp. 35-36, 66, 68. After reviewing the various equations that have been proposed for the corrosion-time relationship in soils, the author finds that his study of some 4,000 pit depth measurements on bare steel and wrought Fe pipes of various ages in Southern Calif. soils supports the log-log type of equation. VVK (11)

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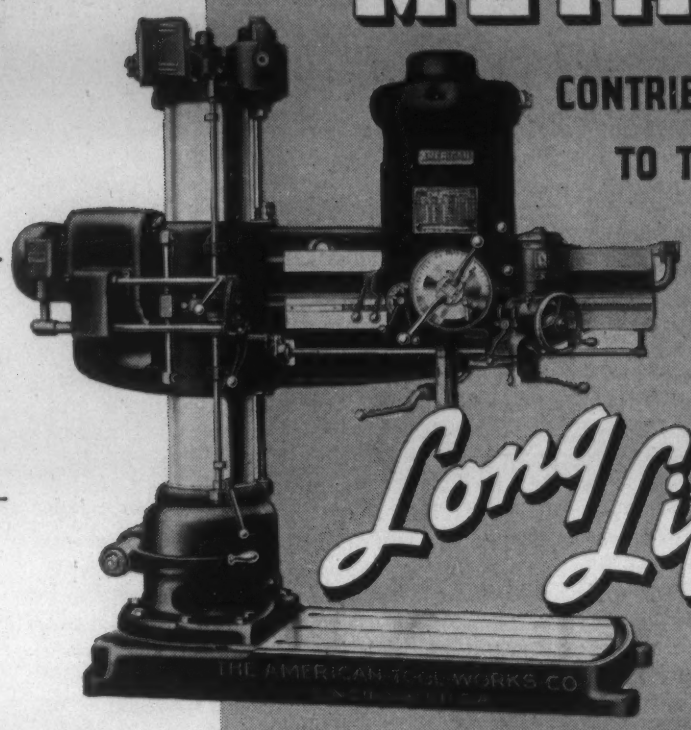

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12 · GENERAL

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

Powder Metallurgy. Commercial Production of Metal Forms. CHARLES HARDY & C. W. BALKE. *Metal Ind., London,* Vol. 53, Aug. 19, 1938, pp. 171-174. Detailed description of modern methods of production of metal forms from metal powders and the characteristics of the product. This method alone has made possible the production of refractory metals in useful form. (W, Mo, Ta.) The entire development in the field of refractory metals and their carbides in the form of cemented material has made the practice of this art a necessity. The composition of alloys can be consistently reproduced with a uniformity unapproachable by foundry methods. Impurities introduced by conventional methods are reduced or eliminated. Aggregates or mixtures can be made of metals which are immiscible in the liquid state or which have widely divergent melting points. (Pb-Cu, Cu-Mo.) The method makes it possible to produce metals in which a non-metal is uniformly disseminated (Cu-graphite, Cu-Sn-graphite). Those practiced in the art have found that the type of die, type of powder, length of time of heat treatment and temperature of sintering can be so controlled that contraction or distortion can be held within very narrow limits. An accuracy of .001 in. is readily obtainable for a number of alloys. Losses of material in normal methods of casting, etc. frequently reduce the weight of the final product to one-half that of the material used. With such losses eliminated by powder methods, finished products may be produced on a competitive basis. Special structural effects can be obtained by powder methods that are not possible by melting processes, and useful bimetals can be made. The high pressure required in most cases to form the material establishes a definite limitation to the application of the process. Many powders cling to the dies and cause uneven pressure, thus limiting the depth of the dies. Difficulty is encountered from oxidation and controlling particle size of the powder. Al, Sb, Bi, brass, bronze, Cd, Cr, Co, Cb, Cu, Au, Fe, Pb, Mn, Mo, Ni, Pd, Si, Ag, Ta, Te, Sn, Ti, W, V, Zn and practically all metal phosphides can be obtained in powder form. Ag-coated Mo and Cu and Cu-coated Ag and Pb powders are available. Metal powders can be produced by various methods determined by the chemical characteristics of the metal. The results obtained are dependent on the purity of the powder used. In the case of any given application of powder metallurgy most of the following properties must be taken into account and held under control: Particle size, particle size range, apparent density, flow factor, shape of particle, cohesive ability, chemical purity and oxide content. Except in cases of mixed lots and different mesh size of powder, pure metal powder does not require mixing. Powders are usually mixed in tumbler or ball mills. They are usually pressed at room temperature. Except where done simultaneously with the pressing operation, the pressed pieces are given an appropriate heat treatment. No fixed rule can be laid down as to the temperature to be employed in the treatment of alloys. In general the temperature used is about ⅔ the melting point of the alloy. With pure refractory metals, which are heated by passing current through the pressed bars, the temperature at the core is brought very close to the melting point. Where porosity is desired, powdered volatile salts are mixed in the metal powder and when heated volatilize, leaving the space they occupied as pores. RWB (12)

Developments in the Iron and Steel Industry During 1937. W. H. BURR. *Iron Steel Engr.,* Vol. 15, Jan. 1938, pp. 46-53. Descriptive. Some details of construction and operation are given for a high pressure steam turbine driven blower and a new type of molten metal transfer car of 125 long tons capacity. Combustion control has received attention, chiefly in regard to the mixing of 2 or more fuels. This entails proper metering and regulation of the fuels, together with proper regulation of the amount of combustion air required. Two new processes of charging open-hearth furnaces are mentioned. In one, the entire cold charge is added at one time by employing a furnace with a removable front and a special charging machine. The second method makes use of top-charging, with large-capacity drop bottom boxes. Special ingot heating furnaces have been developed which permit very accurate control of temp. One of these is of the rotary type and is self-emptying. Photo-electric cells are used for temp. control in a new forging heater. An outstanding type of heater is one which actually rolls long "sucker bars" through the furnace chamber, delivering them normalized and absolutely straight. Developments in recuperators include a type which makes it possible to clean out the spaces between tubes during operation and one which successfully utilizes straight blast furnace gas for soaking pit heating. Strip mill developments have been quite marked, particular emphasis being applied to speed. A special uncoiler for hot rolled strip permits uncoiling at a high rate of speed without coil breaks. Bearing and lubrication improvements include improvements in oil-sleeve, ball- and non-metallic bearings, lubrication systems and the lubricants themselves. Outstanding in the shearing field has been the development of automatic equipment which makes possible speeds of 400-500 feet per min. with absolute accuracy as to cuts. REB (12)

Alloys of Silver and Iron. COLIN G. FINK & V. S. DE MARCHI (Columbia Univ.) *Trans. Electrochem, Soc.,* Vol. 74, 1938, Preprint No. 25, 10 pp. Original research. Ag-Fe alloys were prepared by powder metallurgy. Fe powder and fine Ag crystals were mixed and compressed into a bar by a pressure of 41 tons/in.^{2} The bar was sintered in a H atmosphere, then cold rolled, and heat treated several times. The following evidence was obtained that a Ag-Fe solid solution containing 0.5-1.0% Ag is formed: (1) Microscopic examination of a Ag-rich alloy showed deeply stained ferrite grains that were attributed to a solution of Ag in Fe. (2) Measurements of the resistivity of the alloys showed that the maximum resistivity (13.17 microhms/cm.^{3}) was exhibited by an alloy containing 0.5-1.0% of Ag. (3) The corrosion of the alloys was measured in 10% HCl and in 30% acetic acid. The alloy containing about 1.0% Ag was the least corroded. AB (12)

The Copper Industry in the Soviet Union (Koppar industrien i socialistiska sovjetrepublikernas union) *Tek. Tid.,* Vol. 68, Sept. 10, 1938 (Section *Bergsvetenskap*) pp. 73-76. Largest Cu deposits in the Soviet are in Kazakstan, the most important of which are the Kounrad and Balkasch deposits. About 4/5 of the production, however, is still coming from the older mines in the Urals. Production in 1936 was about 100,000 metric tons of Cu, with an estimated 130,000 in 1937. During the last years the industry has been widely mechanized, and flotation methods have been generally introduced. Electrolytic Cu is produced at Pishmin refinery, with annual capacity of about 100,000 tons. The anode slimes are treated for Au and Ag in the Kyshtim plant. BHS (12)

News from the Patent Literature (Neues aus dem Patentschrifttum) E. HERRMANN. *Aluminium,* Vol. 20, Sept. 1938, pp. 621-630. Review. Recent improvements in melting processes, alloying of Al-Mg, bearing metals with 3-5% Pb, 3-8% Ca, 3-5% Sb, or Si, Mg and Mn added to Al, casting methods, die-casting, welding, extruding, degreasing and mechanical plating (cladding) are described as reflected in patent literature. A new feature is the replacement of Pb by pure (99.5) Al (or even higher purity) for cable sheaths; the material is made plastic by annealing at 350° C., when it has a tensile strength of 7,800 to 8,500 lbs./in.^{2} and an elongation of 40-55%. 33 references. Ha (12)

Radium. Sources of Production—Treatment of Minerals (Le Radium. Source de Production—Traitement des Minerais) E. PROST. *Rev. Universelle Mines,* Vol. 14, Oct. 1938, pp. 741-751. Exhaustive survey. The various deposits of Ra in the Belgian Congo, Canada and Czechoslovakia (Joachimstal), besides the less important ones in U. S. A. and Madagascar, are described. Properties, chemical composition, methods of extraction, and geological conditions are discussed, and production statistics added. The present price is about $50,000 per g. Ra. 11 references. Ha (12)

Electrochemical Power. Editorial Staff, *Chem. & Met. Eng.,* Vol. 45, Sept. 1938, pp. 462-471. Summary of the Federal Power Commission's comprehensive report on the "Power Requirements in Electrochemical, Electrometallurgical and Allied Industries". Among possibilities in the Pacific Northwest are mentioned Al production from foreign ore and electric production of Fe and steel. Tables give a forecast of consumption of electrical energy per year for some metallurgical industries, as well as electrical energy requirements per short ton. PRK (12)

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Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 West 42nd Street, New York.*

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POSITION WANTED: Electric Steel Melter. Technical training, 20 years' melting experience, acid and basic practice, castings or ingots, chemical laboratory experience. Able to take charge of melting department. Box MA-116.

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books

Methods of Mechanical Testing of Metals at Elevated Temperatures *(In Russian)*

A. M. Borzdika

Ferrous Metallurgy Publication Office, Moscow, 1938. Paper, 6 x 9 in., 192 pages. Price 4 rubles.

The book is divided into two parts. The first part presents a general discussion of different methods of heating specimens, measuring and regulating temperature, and measuring deformation. The second, which describes different methods of testing at elevated temperatures, consists of six chapters, of which the first and second relate to the ordinary tensile strength and creep tests, and the others to descriptions of the torsion, impact, fatigue and hardness methods of testing.

The author believes that testing machines having less than ten tons loading capacity should be employed in the tensile test. In his opinion, the universal testing machine designed by Prince Gagarin (known in Russia as "Gagarin's Press") presents many advantages, as compared with other testing machines. [This machine was constructed in Russia by Prince Gagarin around 1900. —A. I. K.]

In Gagarin's machine an almost perfect automatic record of the load-deformation diagram may be obtained. Each millimeter of the abscissa on that diagram is equivalent to 0.01 mm. deformation. In emphasizing the great importance of the time factor in the tensile test, the author gives a table showing the results obtained by him with lead and nickel-chromium steel, the duration of load application until the moment of break being varied in tests:

Material	Temperature Deg. C.	Duration of Test to Breaking Point	Tensile Strength lbs./in.^{2}
Lead	25	1 min.	3,450
	25	10 min.	2,910
	25	60 min.	2,440
	25	180 min.	2,200
Steel containing 0.5% C, 13% Ni, 15% Cr, 2.2% W	600	3-5 min.	81,000
	700	3-5 min.	72,500
	800	3-5 min.	62,500
	900	3-5 min.	35,500
	600	15-20 min.	74,000
	700	15-20 min.	57,000
	800	15-20 min.	32,500
	900	15-20 min.	18,500

In the discussion of the creep test it is mentioned that in one of the creep test laboratories in Russia, four creep torsion testing machines have been installed.

In general, this book may be considered as a text book for students and contains little information new to engineers.—A. I. KRYNITSKY.

The Protection of Ferrous Metals by Phosphate Treatments *(La protezione fosfatica dei metalli ferrosi)*

O. Macchia

O. Lavagnolo, Torino, 1938. Paper, 6¾ x 9½ in., 424 pages. Price 35 lire.

To the urge to substitute protected steel for more expensive non-ferrous metals in Italy, this useful monograph can be ascribed. Some use has been made of phosphate coatings in Italy since 1929, but the rapid methods in which the coating is applied electrolytically or by spraying have not yet been adopted there.

This book seeks to do missionary work, especially in setting forth the suitability of the coatings as primers for some varnish-like types of top coat. It seeks also to replace commercial propaganda by discussing the processes in terms of chemical compounds and the variables involved rather than in trade names. Of some 400 references, only about a score relate to the chemistry of phosphate coatings in a fundamental manner. Prominent among the fundamental publications are several of recent date in Russian, whose meat is given. Since Italian is more intelligible to the average English speaking engineer than Russian, this is a valuable feature of the book.

The historical development of the processes is discussed, primarily in terms of the patent literature. The bath compositions, the effects of the manganese or zinc, of nitrate additions, and of impurities in the phosphoric acid, the methods of cleaning the surface so it will best take the coating, the effect of composition and structure of the steel, chemical control of bath composition, etc., are discussed in detail, often by means of tables or curves, with the behavior of the coating under salt spray or some similar break-down tests as the criterion. The book doubtless gives the fullest published description of the variables involved in the production of satisfactory phosphate coatings. Coating defects are discussed with illustrations and explanations of their causes.

Commercial methods of, and equipment for, application of the coatings are described and pictured, most of the information relating to immersion for quite long periods in solutions heated nearly to boiling. The information on the more rapid methods is less complete and is drawn chiefly from Westinghouse and Ford practice.

Over 75 pages are devoted to the annotated bibliography. The paper used is not very good so that many of the photographic illustrations do not do justice to their originals, though one can generally make out what they are intended to convey. While the contents are equally well written and form as valuable a reference work on this subject as Macchia's previous book on chromium plating, the book making is not up to the standard of that volume. —H. W. GILLETT.

Pewter—Spun, Wrought and Cast

Burl N. Osburn & Gordon O. Wilber

International Textbook Co., Scranton, 1938. Cloth, 7¾ x 10¾ in., 151 pages. Price $2.50.

The authors are instructors at state normal schools or teachers' colleges. Many of the pewter articles illustrated were made by their students. Very detailed instructions are given on how to hammer, spin or otherwise shape pewter and how to cast and solder it. The book is a combination of manual training and of art appreciation in which simplicity and functional utility are stressed as true beauty in contrast to ornamentation for ornamentation's sake alone.

Pewter is so easy to work and has such a pleasing appearance that it is an ideal material for the dual purpose of training the hand to form and the eye to appreciate. One can imagine a man, woman, or child taking great pleasure in making his own

gadgets from pewter in idle hours, much as the sailor does scrimshaw.

There is little metallurgy in the book, though one who works up the alloy as directed will gain quite an understanding of the fundamentals of casting and working. The history of pewter is dealt with interestingly, and the fact brought out that in Colonial days most of the articles and dishes now made in china, silver plate, etc., were of pewter.

After the putterer (we almost said pewterer) has made the objects described by Osburn and Wilber, he will want to try his hand at making other things in the style shown in Bulletin 3 of the International Tin Research and Development Council, "Contemporary Pewter in the Netherlands."—H. W. GILLETT.

Dental Materials

John S. Shell

C. V. Mosby Co., St. Louis, 1938. Cloth, 6 x 9 in., 413 pages. Price $4.50.

This new text is to some extent a revision of *Practical Dental Metallurgy* by Hodgen, but the revision has been extensive and much new material has been included. Likewise, much material on process metallurgy and chemistry has been eliminated. This new publication has been designed to meet the specifications set up by the "Report of the Curriculum Survey Committee of the American Association of Dental Schools" which gave as the objective "To understand the sources, composition and properties of all materials used."

The scope can be indicated by the chapter titles: Characteristics of Metals, Theory of Alloys, Metallography, Low Fusing Base Metals, High Fusing Base Metals, Noble Metals, Gold, Mechanical Properties of Metals, Gold Alloys Used in Dentistry, Base Metal Substitutes for Gold in Dentistry, Heat Treatment of Dental Alloys, Chemical and Electrochemical Reactions of Dental Alloys, Amalgams, Dental Castings, Pyrometry, Refractory Materials, Heating Equipment, Dental Porcelain, Dental Cements, Vulcanized Rubber Dentures, Synthetic Plastics, and Organic Technique Materials.

This arrangement gives about 80% of the volume to metallic materials and related subjects and this distribution might not be approved by all colleges. The order in which the various subjects are presented may not meet with entire approval by all teachers. For example, Chapter 12 presents the heat treatment of dental alloys while pyrometry comes later in Chapter 16 and heating equipment still later in Chapter 18. Gold alloys used in dentistry are covered in Chapter 10, but dental castings are presented in Chapter 15. This arrangement is not serious, however, because the individual teacher can select his own order of presenting the subjects.

The author has taken a forward step in introducing good chapters on the theory of alloys and metallography. Presented from a fundamental point of view, they should be of value to students in dentistry and might be read to advantage also by some of the practicing dentists who want to know more about the materials they are using.

The scheme used in giving the properties of metals and alloys and then showing their uses in dentistry seems to be a good one.

Dental students are more interested in materials if they can be convinced that such information will be of value in their contemplated profession. In some respects the text may tend toward the research or testing point of view too much for the average student. However, more information along these lines and a broader viewpoint should be valuable.

The author has presented quite an extensive treatment of the various subjects and has brought the information up to date. Besides the text there are extensive references to original literature at the end of each chapter. The author has also drawn upon his own researches for data and presents some original information. The writing style is generally easy to read and the publishers have done a good job, with one exception, *i.e.*, the photomicrographs are not good in many cases. That, however, is common in American publications where the same paper is used as that for the printed text. The index is excellent and makes it very convenient to find information; the illustrations also add to the value of this publication.

The book is of decided metallurgical interest, and should be used by teachers and students in dental alloys, by practicing dentists and by manufacturers of the various materials.—OSCAR E. HARDER.

Digest of Properties, Carbon and Alloy Steel Tubing for High Temperature, High Pressure Service.

Babcock & Wilcox Tube Co., Beaver Falls, Pa., 1938. 8½ x 11 in., 76 pages.

This new edition contains added information on the high-temperature properties of the various gradations of compositions of B & W tube steels, from plain carbon to 25 per cent Cr/20 per cent Ni. Especial attention is given to a steel of 2¼ per cent Cr/1 per cent Mo whose creep resistance over the range 900-1200 deg. F. is outstanding among pearlitic steels.

An especially interesting section relates to creep testing practice of Professor Norton at M.I.T., where 3,000-hr. tests are standard, and a special furnace, controlled within ±0.2 deg. F. is used with a 10-in. test length to determine the creep rate to the nearest 0.1 per cent in 100,000 hr.

The effects of alloying elements on high-temperature properties are concisely discussed. The pamphlet is of interest to a much wider group than the users of tubing. It bears evidence of preparation by metallurgical experts rather than by those who prepare most commercial booklets.—H. W. GILLETT.

Machining of Metals

American Society for Metals, Cleveland, 1938. Cloth, 6 x 9 in., 177 pages. Price $2.50.

Five lectures are included: *The Physics of Metal Cutting*, by H. Ernst; *Machinability of Ingot Iron, Wrought Iron, S.A.E. Steels, and Stainless Steels*, by H. B. Knowlton; *Machinability of Cast Steel, Cast and Malleable Iron*, by J. W. Bolton; *Machinability of Tool Steels*, by A. H. d'Arcambal and W. E. Bancroft; and *Machining of Non-ferrous Metals*, by H. P. Croft.

In addition to giving a very good picture of the general problem of machinability, some of the specific data are very interesting. Ernst's demonstration of the effect of the temperature of the metal cut, leading to the prognostication that machinability may some day be commercially controlled by cooling to very low temperature, is in this class. Bolton finds that phosphorus in medium-strength cast iron tends to improve machinability if the chips are kept out of the path of the tool. It is interesting to note that the explanation for the behavior of phosphorus is that it reduces the "ductility" of cast iron. Both Bolton and Croft emphasize the value of carbide tools for machining alloys with firmly held abrasive particles, like high-phosphorus strong cast iron and aluminum-silicon alloys. All the authors bring out clearly the relation between structure and machinability.

The title is something of a misnomer, for a discussion of machining would involve tool compositions, angles, speeds and feeds, and cutting compounds. While incidental data on some of these points are included, especially in the appendix to Knowlton's discussion, the emphasis is laid on the properties of the metal cut. This attention to machinability rather than machining unifies the whole series and leaves the reader with a clear-cut impression. The book is decidedly worth its price.—H. W. GILLETT.

CURRENT news

Conventions in Early 1939

Dates have been announced for the 1939 conventions of four technical organizations. They are as follows:

The annual convention of the American Institute of Mining and Metallurgical Engineers (A.I.M.E.) will be held at the Engineering Societies Building, New York, Feb. 13 to 16.

The regular yearly conference of the Open-Hearth Committee of the A. I. M. E. is scheduled to be held at the Cleveland Hotel, Cleveland, April 26 to 28. The Blast Furnace Committee of the same society will join in this conference.

The Spring Meeting of The Electrochemical Society will be held at the Deschler-Wallich Hotel, Columbus, Ohio, April 26 to 29.

The annual convention of the American Foundrymen's Association has been arranged as a technical meeting without an exhibition in Cincinnati. The date is May 15 to 18.

The Spring Group Meetings of the Committees of the American Society for Testing Materials will be held in Columbus, Ohio, March 6 to 10. The annual convention of the A. S. T. M. is set for Atlantic City, N. J., June 26 to 30. An exhibit will be a feature.

Annual Show of Tool Engineers

Details of the second annual Machine and Tool Progress Exhibition, to be held in Detroit, March 14 to 18, 1939, have been announced by Frank A. Shuler, Chrysler Corp., and chairman of the show committee. The show will be held in Convention Hall, Detroit, the locale of last year's startlingly successful exhibition. According to reservations already being received at the headquarters' offices of the American Society of Tool Engineers, sponsors of the show, the exhibition will roughly triple the size of the 1938 exhibition. Exhibits will cover all forms of machines, tools, equipment and processes of interest to manufacturing executives ("Tool Engineers") in the mass production industries.

As a result of the unprecedented demand for space it has been decided to limit exhibit space for each exhibitor. Exact limitations have not as yet been announced as these will have to be approved by the committee as a whole. Practically every exhibitor from last year's show, however, has requested larger space at the 1939 show.

The committee is also planning to secure the cooperation of exhibitors in seeing that the exhibits themselves are of the "operating" type.

Light-Weight High-Speed Passenger Trains

The extent to which the railroads have been able to recapture some of their lost passenger traffic and revenues through the introduction and operation of light-weight trains is factually revealed in a 68-page report "Streamline, Light-Weight, High-Speed Passenger Trains," prepared for the Edward G. Budd Mfg. Co. by Coverdale & Colpitts, consulting engineers, New York. The report discusses the general background and impelling forces behind the trend to light, fast passenger trains, then analyzes in detail the construction, operating factors, growth of traffic and revenues and expenses of each of the new trains.

Approximately 60 individual trains are discussed, some made by Pullman-Standard Car Mfg. Co., some by Budd, some by American Car and Foundry Co. The Pullman Co. has tended to feature aluminum alloy as the weight saving medium but has used some low-alloy and stainless steels; Budd's greatest contributions have been the use of high-tensile stainless steel and the shot welding process in fabrication; A. C. F. has employed low-alloy high strength steels in some trains and aluminum in others. Also important have been the devising and adapting by Electro-Motive Corporation of a 2-cycle Diesel engine practicable for high-speed train service.

In all cases where it was possible, in preparing the report, to segregate the effect of introducing a new train from other effects on traffic volume, a decided growth in traffic could be attributed to passenger acceptance of the innovation. In one case where a new light-weight train was periodically replaced on a certain run by a conventional train, a noticeable falling-off in traffic occurred during each replacement period. It is clear from the opinions given by officials of the various lines that a large proportion of the traffic on the new light-weight, high-speed trains has been newly created or retrieved from the highways.

The outstanding facts that the report reveals, however, are the great popularity and financial success attained in the operation of these trains. For this, much credit must go to the metallurgical engineers whose intelligent application of modern metals and alloys has assisted a harassed industry in increasing its revenues.

Tool Engineers Charter 23rd Chapter

The American Society of Tool Engineers' twenty-third chapter was chartered Dec. 2 at an organization meeting held at the Fort Armstrong Hotel at Rock Island, Ill. To be known as the Tri-Cities Chapter, it will include the entire industrial district around the cities of Moline, East Moline, Rock Island, Ill., and Davenport, Iowa. Fifty-five charter members at the organization meeting elected Otto R. Reller, production manager, Moline Tool Co., as chapter chairman; Joseph B. Morganthall, chief tool designer, John Deere Wagon Works, vice-chairman; Kenneth C. Jasper, tool designer, Rock Island Arsenal, secretary; and W. Z. Fidler, chief draftsman of Reynolds Engineering Co., Rock Island, Ill., treasurer.

Walter F. Wagner, President of the American Society of Tool Engineers and Ford R. Lamb, Executive Secretary, presented the Chapter with its charter at the organization meeting.

● The Chas. Taylor Sons Co. has recently appointed the International Allied Engineering Co. as exclusive sales representatives on "P. B. Sillimanite" and refractory specialties in Argentina, Brazil, Chile, Peru and Uruguay. The company can now offer Sillimanite products to the metal trades in all countries of this hemisphere.

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Kuhlman Electric Co. Absorbs Detroit Electric Furnace Co.

The Kuhlman Electric Co., Bay City, Mich., has purchased the Detroit Electric Furnace Co.'s business and will hereafter operate it as the Detroit Electric Furnace, Division of Kuhlman Electric Co., Bay City, Mich.

There will be no interruption to the servicing of Detroit electric furnaces. The same sales, service and production personnel which have been with the company for many years will continue in the conduct of the company's business under the direction of A. E. Rhoads. Kuhlman Electric Co., as a manufacturer of transformers for almost a half century, was one of the earliest builders of furnace transformers. They have designed and built the transformers for several hundred installations of Detroit Electric Furnaces during the past 20 years. The Detroit Electric Furnace Co. reports a substantial back-log of furnace orders on hand. Several of these will be completed and shipped from Detroit; the remainder will be built on schedule and shipped from Bay City early in 1939. All correspondence should be addressed to the company at Bay City, Mich.

Air Filter Research at Mellon Institute

Dr. Edward R. Weidlein, director, Mellon Institute, Pittsburgh, has announced the establishment of an Industrial Fellowship in that Institution by the American Air Filter Co., Inc., of Louisville, Ky. This fellowship will investigate broadly materials of value in the construction of filters for air-conditioning systems. It will be the aim to gain through this research new knowledge to effect all possible improvements in the devices manufactured by the donor, and in this work the Fellowship will have the direct cooperation of specialists on the staff of the Multiple Industrial Fellowship on air hygiene in operation in the Institute.

Dr. Frank F. Rupert, who has been appointed to the Incumbency of the Fellowship, has been a member of Mellon Institute since 1913.

Dr. Sachs Joins Case Faculty

Dr. George Sachs, prominent European authority on physical metallurgy, will join the faculty of Case School of Applied Science in February, as recently announced by Prof. K. H. Donaldson, head of the metallurgy department. Dr. Sachs will begin his work at Case with the opening of second semester classes on Feb. 6 and will supervise X-ray and research work in the graduate division as well as teach undergraduate courses in the physics of metals.

He has done intensive work in industrial metallurgical research and will come to Case from the Baker Chemical Co. in New Jersey where he is head of the precious metals department. He was born in Moscow, Russia, and educated at the Technische Hochschule in Berlin where he received his bachelor's degree in civil engineering in 1920 and his doctorate degree in mechanical engineering in 1921.

Francis Hodgkinson Receives Holley Medal

The Holley Medal of The American Society of Mechanical Engineers was awarded to Francis Hodgkinson, honorary professor of mechanical engineering at Columbia University and former associate of George Westinghouse, for "meritorious services in the development of the steam turbine." The award was made during A.S.M.E. Honors Night ceremonies at the Engineering Societies Building, 29 West 39th St., during the Annual Convention in New York.

Stainless Steel's 25th Anniversary

More than 100 of the leading members of the steel industry gathered to commemorate the "twenty-fifth Anniversary of the Discovery of Stainless Steel" at a dinner held in the Duquesne Club on Dec. 13. Addresses were delivered by Dr. V. N. Krivobok, associate director of research, Allegheny-Ludlum Steel Corp., who spoke on "The Origin and Development of Stainless Steel"; L. S. Bergen, associate director of metallurgy and research, Crucible Steel Co. of America, on "The Standardization of Stainless Alloys," and John H. Van Deventer, editor of *The Iron Age*, on the "Commercial Aspects of Stainless." A tribute in the form of a toast was paid Harry Brearley, discoverer of stainless steel in 1913, by the toastmaster, Benjamin F. Fairless, president, U. S. Steel Corp.

Bethlehem Granted License to Make "Ledloy"

The Bethlehem Steel Co., Bethlehem, Pa., has taken out a license to make leaded steels under Inland patents. Lead-bearing steels, as recently developed by Inland, are reported as becoming increasingly popular with manufacturers. It is stated that tests have shown that the physical properties of steel are unaffected by the lead additions, and that at the same time remarkable records for increased machinability and greatly lengthened tool life are being reported daily.

● The "Elastuf Group of Related Machinery Steels," developed by the Horace T. Potts Co. of Philadelphia, are now available over a large section of the Eastern industrial territory. Formerly distributed entirely through Potts warehouses in Philadelphia and Baltimore, and through Brown-Wales in Boston, these special formula steels can now be obtained through Beals, McCarthy & Rogers in Buffalo, and Equitable Equipment Co. in New Orleans. The Elastuf steels include a number of grades of machinable steels offering high tensile properties without the need for intermediate heat treatments.

● Norbert Stern, Pittsburgh, president of Barium & Chemicals, Inc., Willoughby, Ohio, announces that they are successors to the J. H. R. Products Co. of Willoughby, which has for the past 20 yrs., manufactured high grade barium compounds and other products. Dr. M. J. Rentschler, who has been associated with the J. H. R. Products Co. since its inception as director of research, will continue in the same capacity with Barium & Chemicals, Inc. The company produces all standard barium compounds, hydrogen peroxide, J. H. R. tank-lining compound, anti-scumming dust and "Bar-ide."

● The Meehanite Metal Corp., Pittsburgh, announces the licensing of the following companies to manufacture Meehanite metal under the Meehanite processes: Valley Iron Works, St. Paul, Minn.; Barnett Foundry & Machine Co., Newark, N. J.; Herbert Morris, Ltd., Loughboro, England; and Douglas Fraser & Sons, Ltd., Arbroath, Scotland.

● The appointment of Ralph Hare as New England representative of The Electro-Alloys Co., Elyria, Ohio, is announced. Mr. Hare will continue to make his headquarters at West Hartford, Conn.

● The appointment of D. J. Richards as manager of steel mill sales is announced by E. F. Houghton & Co., oils, leathers and metal working products, Philadelphia.

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THAT book of matches in your pocket would fall apart except for that inconspicuous piece of stapling wire. *It takes approximately 444 miles of that wire every day to supply the enormous demand for book matches.*

Steel is even more important in almost every act of your daily life. Many food delicacies come to you in tin plated steel cans and are cooked on a steel range; the modern plumbing and heating of your house would be impossible except for steel; your clothes, glasses, watch, shoes.... all contain vital steel parts; you probably travel in a steel automobile or train to a steel framed office building or factory, to work at a steel desk or machine.

All the comforts and conveniences of modern life, which have come to be considered necessities, have been made possible by modern refinements in steels. Such refinements in steels do not just happen .... Youngstown maintains a great laboratory and an experienced organization, always working with customers to find the steel best suited to their needs and products.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - - YOUNGSTOWN, OHIO

Sheets - Plates - Pipe and Tubular Products - Conduit - Tin Plate
Bars - Rods - Wire - Nails - Unions - Tie Plates and Spikes 25-10A

YOUNGSTOWN

trends

Lighter Transportation Equipment

Our first article this month—Aluminum Alloys in the Railroad Industry—is another which discusses a trend in the substitution of alloys or alloy steels for plain carbon steels, particularly in transportation equipment, so as to decrease the dead weight and to increase the pay load without sacrifice of essential properties. The author presents the case for aluminum alloys. This article supplements the review of the present status for the low-alloy steels in our October issue. Undoubtedly the greater use of both aluminum alloys and low alloy, high strength steels is assured. Ultimate rehabilitation of railroad equipment alone seems a certainty.

Molybdenum

The trend in the demand for molybdenum as an alloying element is steadily upward. It is not too late to call attention to the fact that Government data for 1937 show that production of molybdenum concentrates in 1937 were 74 per cent larger than for 1936 and 155 per cent in excess of 1935. The statistics also show that shipments of Mo-contained material were 67.7 per cent greater than those of 1936 and 176 per cent over those of 1935.

Viewed from any angle these facts tell an encouraging and significant story—expanding recognition of the value of this alloying metal and the growing breadth of the alloy steel and iron industry as a whole.

German and American Steel Output

For the first time in many, many years and possibly in history, the pig iron and the steel output of Germany for the first half of 1938 exceeded that of the United States. Germany made 10,581,960 metric tons of pig iron as compared with 7,873,000 gross tons for American furnaces. In steel the German total was 13,204,394 metric tons while the American was 10,819,144 gross tons. The American iron and steel output has not in recent years been topped by any other country. The 1938 totals are not yet available but it is not unlikely that the comparison will hold true for the year. While this is an interesting and rather startling fact, and while Germany's producing resources are on the increase, when prosperity returns in this country, the above trend will probably be reversed and revert to normal.

Powder Metallurgy

There are accumulating evidences of the future commercial importance of powder metallurgy. For some time the discussions by Hardy and quite recently the paper by Gregory Comstock have presented the present status of this development with a glimpse of its possibilities. Now comes the information that a "seminar course of two hours per week to discuss the problems of powder metallurgy" has been arranged for at Massachusetts Institute of Technology. This will be followed by "a laboratory course the second term on problems connected with the field." Visualization of the probable future developments in this field is not difficult.

Research

That interest in the value of research in metals is not on the wane but is distinctly expanding is demonstrated by the establishing of new research laboratories by industrial companies in the metal industry. Two of the more recent examples of this tendency is the large laboratory of the Jones & Laughlin Steel Co., Pittsburgh, and that of the Crane Co., Chicago. Both of these contain the latest equipment for research in many fields and are manned by scientists who are competent to get results.

Metals and Alloys in Dairy Equipment

We visited the very large exhibit of the dairy industries in Cleveland recently where over $2,000,000 worth of various kinds of equipment was displayed—a very impressive affair. Stainless steel predominated—probably more was assembled in the Cleveland Public Hall than anywhere before in one place as fabricated material. It is only in recent years that the dairy industry has adopted solid metals such as stainless steel, nickel, aluminum alloys and so on. The trend has been and still is decidedly away from coated metals. These were used in the early days.

Scrap Exports

In our October, 1938, issue we called attention editorially to the spectacular demand for American scrap iron and steel, emphasizing the record exports in 1937 of over 4,092,000 gross tons or 341,000 tons per month, mostly to Japan. The 1937 all-time record volume was approximately twice the average exports for 1934, 1935, or 1936. The trend for 1938 has been downward—to Nov. 1, the total had been over 2,406,300 tons or about 240,600 tons monthly, also the bulk to Japan. Despite this downward trend, the average monthly volume still exceeds that for 1934, 1935, or 1936.

Expansion in Steel Capacity

As the result of technical progress in furnace construction, principally open-hearth, the trend in steel manufacturing capacity in the United States has expanded about 1,030 per cent since 1889 but there has not been a corresponding increase in the number of furnaces—according to the American Iron and Steel Institute. The number of furnaces has expanded only 350 per cent. And the average annual productive capacity of each steel producing unit is about 62,000 tons as compared with 25,000 tons in 1889, an increase of about 150 per cent in 50 years,—truly a testimonial to technical research and a trend likely to continue.

by Edwin F. Cone, Editor

New Equipment and Materials

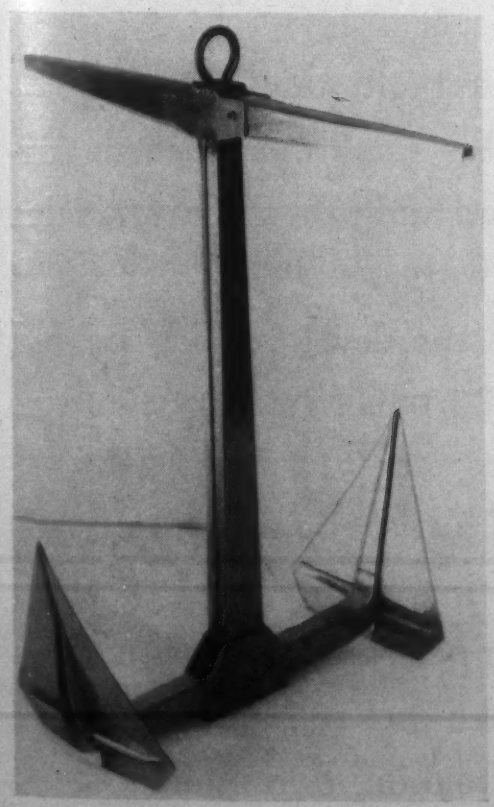
Lightweight Anchor

One of the latest developments in the marine accessory field, introduced at the recent motor boat show in New York, is a new lightweight anchor fabricated from high strength Monel metal sheet. It is welded throughout, except where the arms and stock meet the shank. These joints are pinned so that the anchor can be folded for stowing when not in use.

Made in a variety of sizes from 6 to 47 lbs., the anchor is so designed that the 11-lb size will hold a boat 38 ft. in length. With the conventional type of anchor the general rule is to allow 1 to 2 lbs. in anchor weight for each foot of boat length. This lightness of weight is made possible by the design of the anchor combined with the inherent strength of Monel.

Arms of the unit are set at right angles to the stock and are equipped with a set of sharp-pointed triangular flukes. These dig deeper and deeper as the pull of the craft is increased. The broad palms of the anchor, which will bury itself completely in bottoms of clay or sand provide an exceptionally strong grip. The anchor will not dig itself out of the bottom until a direct upward pull is exerted on the line. Then, the sharp-pointed flukes readily cut their way out.

The lightweight and small size of the anchor are pointed to as permitting ease of handling and of reducing the danger of damage to the hull and topsides. Monel is highly resistant to corrosion.



Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts no more than 2 in. wide.

Designed and manufactured by the Youngstown Welding & Engineering Co., Youngstown, Ohio, the unit has not yet been assigned a name. This will await the outcome of a prize name contest conducted by the company. It will close on March 15.

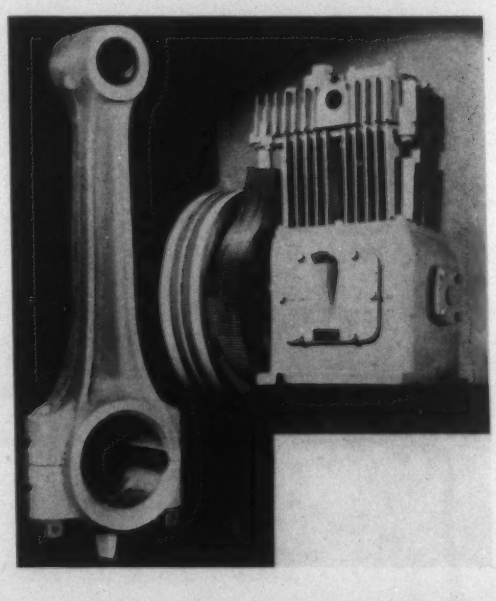
Non-Ferrous Alloy, Strong and Hard As Steel

As a recent addition to their line of standard and special alloy non-ferrous castings, the A. W. Cadman Mfg. Co., Pittsburgh, is equipped and qualified to make castings of Cupaloy under license of Westinghouse Electric & Mfg. Co. This new copper alloy, having the desirable thermal and electrical properties and at the same time free from the mechanical weaknesses of copper, is as strong and hard as 0.30 carbon steel, retaining these characteristics at the high operating temperature of 750° F. in continuous service, is now available in cast shapes made by the Cadman Company—a well known non-ferrous foundry established in 1860.

Some of the uses for Cupaloy include: Resistance welding electrodes, spot welding tips, holder jaws and clamps, welding discs, arc welding electrode holders, welding machine structural parts (non magnetic) and welding bells; motor and generator slip rings, coil conductors and commutator bars and segments, brush springs and holders; switch gear bodies, contact and clapper pads; transformer terminal studs and structural parts subjected to high physical stresses and heavy current; controller, overload relay, circuit breaker and safety switch structural parts and contacts; trolley wheels and gliders, third rail collector shoes, electroplating structural parts carrying heavy current, springs of all types where a high ratio of conductivity to strength is required; fuse clips, electric marking points, electrically upsetting rivets. Aside from castings made from any conventional shape that may be produced by regular foundry technique Cupaloy is also available in rolled or drawn round, square and rectangular bars, strips, forged discs and extruded shapes.

Aluminum Connecting Rods

With the advances in aluminum technique and with the development of new, stronger alloys, the possibilities of aluminum connecting rods are again being considered very carefully by engineers in the automotive field. The rod, shown herewith, was recently developed by the Bohn Aluminum and Brass Corp., Detroit, for the new line of Quincy air compressors. This compressor was designed to have exceptionally high over-all efficiency in delivering the greatest amount of air possible per unit of power consumed. Saving weight in the reciprocating parts was highly essential for mechanical efficiency as well as for smooth operation.



By adopting the "Bohnalite" connecting rod illustrated, a saving of 40 per cent in weight over steel was accomplished with the consequent reduction in vibration and mechanical losses. The illustration shows the compressor with an enlarged view of this forged aluminum connecting rod.

Induction Furnace for Sintering

Chas. Hardy, Inc., 415 Lexington Ave., New York, announces "a development of paramount importance to the field of powder metallurgy." It is an induction furnace for sintering metal powders at extraordinarily high frequencies. By arrangement with the Ohio Crankshaft Co. —Tocco Division—Cleveland, the Hardy organization is the exclusive distributor of "Hardy-Lepel" high frequency sintering furnaces and for Lepel electric power converters for powder metallurgy applications.

(Continued on page MA 74)

MAKING STEEL BY THE POUND...

HOW THE LITTLE OPEN-HEARTH FURNACE IN JONES & LAUGHLIN'S NEW PILOT PLANT LABORATORY DIRECTS THE MANUFACTURE OF **CONTROLLED QUALITY** STEEL IN ITS WORKS.

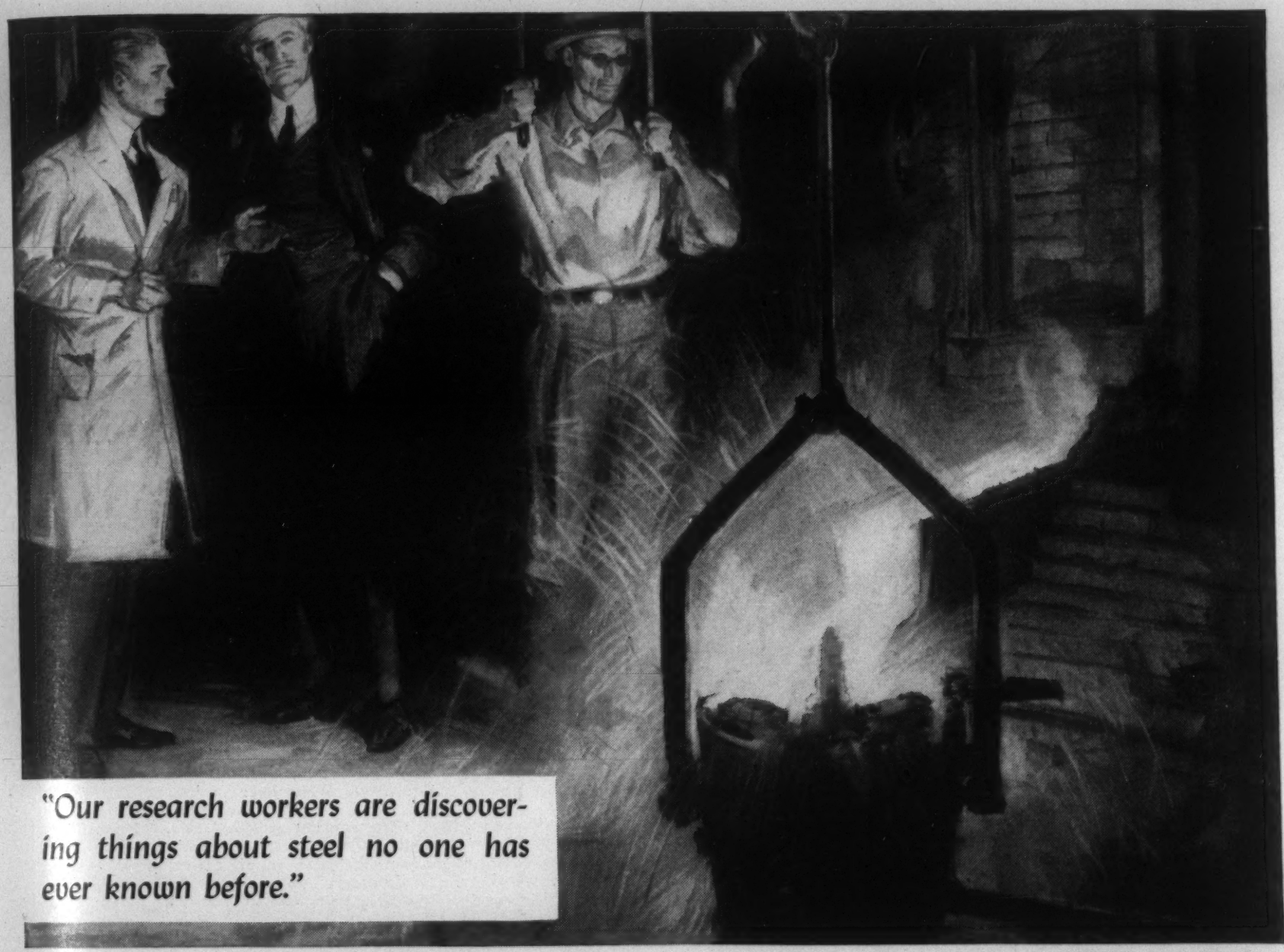
"Here in our new Pilot Plant laboratory—the first and only one of its kind—our metallurgists and engineers designed and built this small open-hearth furnace to facilitate research in steel making. We develop and prove new formulas here and new quality controls for the big furnaces in the steel works.

"This small furnace makes steel in only 1500-pound lots, yet the developments proved here are readily applied in the large furnaces which produce 100 tons of steel or more in a single operation.

"The man in the old battered hat you see operating this 'baby' furnace is a college graduate—a research metallurgist. His two helpers have been making quality steel all their lives in the tradition of craftsmanship built up by J & L over a period of 89 years. They can read temperatures by peering into a furnace—they can tell the carbon content of steel by looking at a broken sample—they are masters of the art of making fine quality steel.

"But now, in our works, as in our laboratory, this art—this craftsmanship—is reinforced by science. With sensitive instruments, we measure and regulate temperatures, analyze

TO IMPROVE IT BY THE TON



From a drawing by ORISON MacPHERSON

the molten steel of the furnaces, make experiments in the Pilot Plant, all to obtain complete control of quality in our commercial production. With the small experimental furnaces and pilot rolling mills in this laboratory, our research workers are discovering things about steel no one has ever known before.

"How does making steel by the pound help you customers who use it by the ton? By improving properties of steels for all your products—developing new steels—opening new fields for you through wider and more profitable use of J & L Controlled Quality Steel."

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

PITTSBURGH, PENNSYLVANIA

J&L STEEL

J & L—PARTNER IN PROGRESS TO AMERICAN INDUSTRY

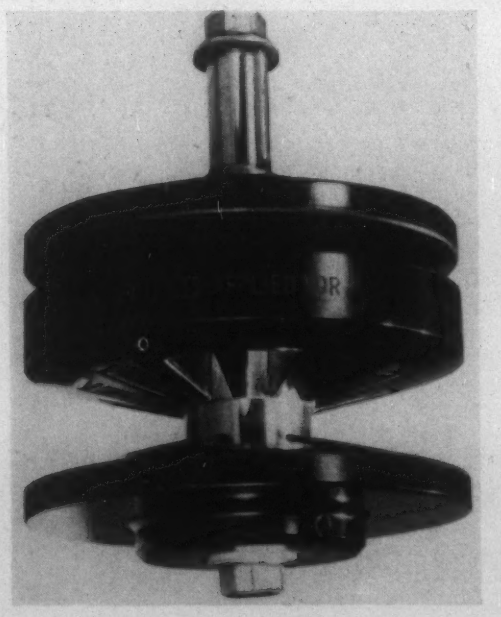
A "Speedmaster" Drive

Continental Machine Specialties of Minneapolis, announce an improved design and lower price for their "Speedmaster Variable Speed Pulleys." These new infinitely variable speed pulleys are molded of solid high impact strength Bakelite, accurately trued and balanced before final assembly. An improved pressure lubricated bronze sleeve allows the splined center sheave member to operate freely, regardless of load or speed.

The new construction is available in two sizes, a 3½-in. dia. size for drives up to ½ hp capacity and a 6½-in. dia. size for drives up to 3 hp capacity. The pulley is said to be very flexible in its adaptability to both "straight line" and "angular" drives. Interposed between motor and driven unit, the position of the pulley can be changed to vary the center distances of the Speedmaster pulley in relation to the drive and driven sheaves. The belts thus assume smaller or larger operating pitch diameters through the action of the variable pulley faces. Control of speed is made through a quick action lever, or a handwheel allowing control of speed within 1 rpm. The entire unit is free floating so that belt alignment is accurately maintained at all times.

Advantages claimed by the manufacturer for the improved Speedmaster are: A 6-to-1 up to a 40-to-1 ratio of infinitely variable speed, the use of standard "V" belts, and long belt and pulley life because of the molded plastic work faces.

This wide range transmission was originally developed for use in the company's "Doall" contour band sawing machine and was later produced as a separate unit for general applications.



Self-Lubricating Bearing Bronze

The Johnson Bronze Co., New Castle, Pa., has put on the market a product which it terms a new type of self-lubricating bearing bronze. It's trade name is "Ledaloyl." Although primarily a sintered type of bearing, it is said to have characteristics never before available through the process of pre-alloying the basic metals, allowing the introduction of both lead and graphite. Pre-alloying is also said to create a uniform grain structure and a thoroughly homogeneous material. A porous structure, which will retain up to 35 per cent oil by volume, when the bearing is vacuum impregnated, is secured by including a definite amount of volatile matter. The capillary structure of the bearing thus permits a flow of oil to the shaft when needed and absorption when not in use.

A Plated Steel

The Standard Steel Spring Co., Coraopolis, Pa., has opened a new electroplating plant especially designed to handle large sections of steel for finishing with nickel plating of a pore-free type, according to W. F. Rockwell, chairman of the company's board of directors.

First shipments from the new plant will go to the Texas oil fields where the inroads of corrosion are increasing production costs, he said. Thorough trials of this pore-free coating which ranges up to 20 times the normal thickness of nickel plating, have demonstrated its resistance to corrosion in the wells. Besides the oil fields the new material is designed for uses in which ordinary steel corrodes badly, thus extending the market for steel in the manufacture of barrels, tanks and other containers for shipping and storing corrosive chemicals.

The new electroplating process which makes this material possible requires accurate technical control, Mr. Rockwell said, but as the process is largely automatic, the results can be duplicated regularly in commercial production. The nickel deposit which constitutes the heavy plate is malleable and withstands abrasive as well as corrosive attack. Thus this new product adds to the list of economical structural materials with corrosion resistant surfaces.

A fellowship has been established at the Mellon Institute of Industrial Research, Pittsburgh, to study the process and assure its scientific application to new fields of use.

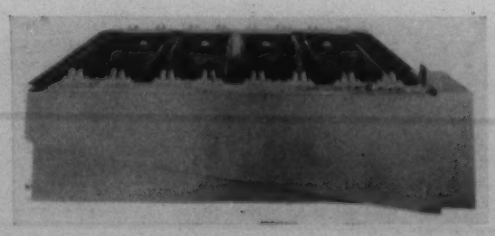
Colloidal Graphite Solves Oven Lubrication Problem

Conveyor chains operating in high temperature zones, such as in baking and enameling ovens, can now be more effectively lubricated as the result of the development of a new product, it is claimed. Common lubricants cannot be used since they would burn off. Colloidal graphite had been tried with varying success, the graphite being suspended in various liquids. The difficulty was with the carrier. Oil, for instance, would burn off, forming undesirable carbon. Smoke and odor were other problems.

The solution was found through the development by Acheson Colloids Corpn., Detroit, of a new form of colloidal graphite, so finely divided that it could be suspended in suitable volatile liquids. The liquid, kerosene in this case, merely evaporates, leaving a very thin deposit of fine colloidal graphite on the surface. Experience has shown that this film of graphite, although extremely thin, provides lasting and economical lubrication for the difficult-to-reach friction surfaces under high operating temperatures.

Hot Solution Plating Barrel

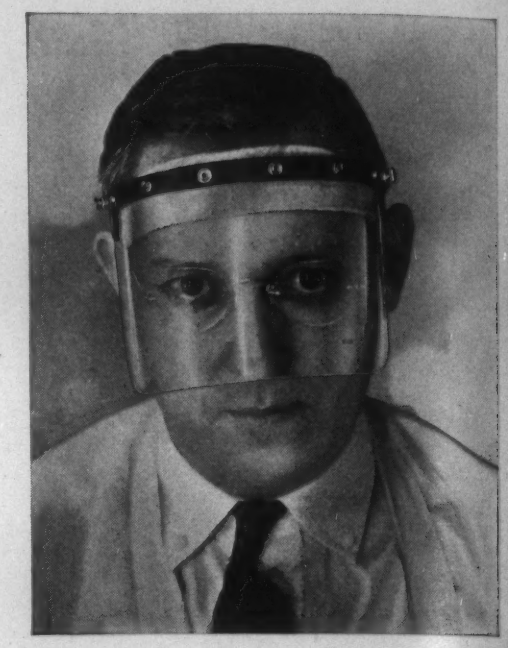
A noteworthy advance in plating barrel construction is said to be embodied in the new Mercel plating barrel tank made by the Hanson-Van Winkle-Munning Co., Matawan, N. J. This tank which is designed for hot solutions, employs a unique method of exhausting the fumes. A series of small ducts directly over the anode rods connect with the main duct on the side. These individual ducts do not interfere with the placement of the cylinders into the tank in their respective saddle brackets, nor do they leave any unsightly cumbersome ducts along the side or above the tanks. The unit is neat in appearance, compact and thoroughly effective.



A Protective Shield for the Face

Willson Products, Inc., 269 Thorn St., Reading, Pa., announces a new "Protecto-Shield" for guarding face of workers in light grinding operations, wood working, spot welding and other occupations where protection is desirable.

The Willson Protecto-Shield permits clear vision in all directions. It is made of thick



transparent cellulose acetate, is well ventilated and large enough to fit comfortably over correction spectacles. The shield extends well back along the sides of the face. It is easily thrown back when not in use. A special Willson knitted sweat pad provides unusual comfort. It is so light in weight that workers have no objection to wearing it.

The adjustable molded rubber headband and all other parts are easily replaceable. Shield may be had in clear, amber, or green transparent cellulose. The manufacturer will gladly furnish complete information, literature and prices on request.

Electric Unit for Industrial Heating

A high-speed Calrod heating unit has been developed by the General Electric Co., Schenectady, N. Y. It is for industrial applications that require temperatures as high as 1500 deg. F.

Although standard listed ratings range from 750 to 3500 watts, and effective heating lengths ordinarily range from 18 to 84 in., other sizes and ratings can be manufactured as required. Among uses of product are applications in high-temperature air heating, industrial ovens with air temperatures up to 1000 deg. F., hotplates, and various metal surfaces.

"Lapix"—for Open-Hearth Operations

A new product has recently been introduced by E. F. Houghton & Co., Philadelphia, for use in open-hearth departments in the treatment of fully killed steel. This is known as "Lapix", a finely powdered insulating material.

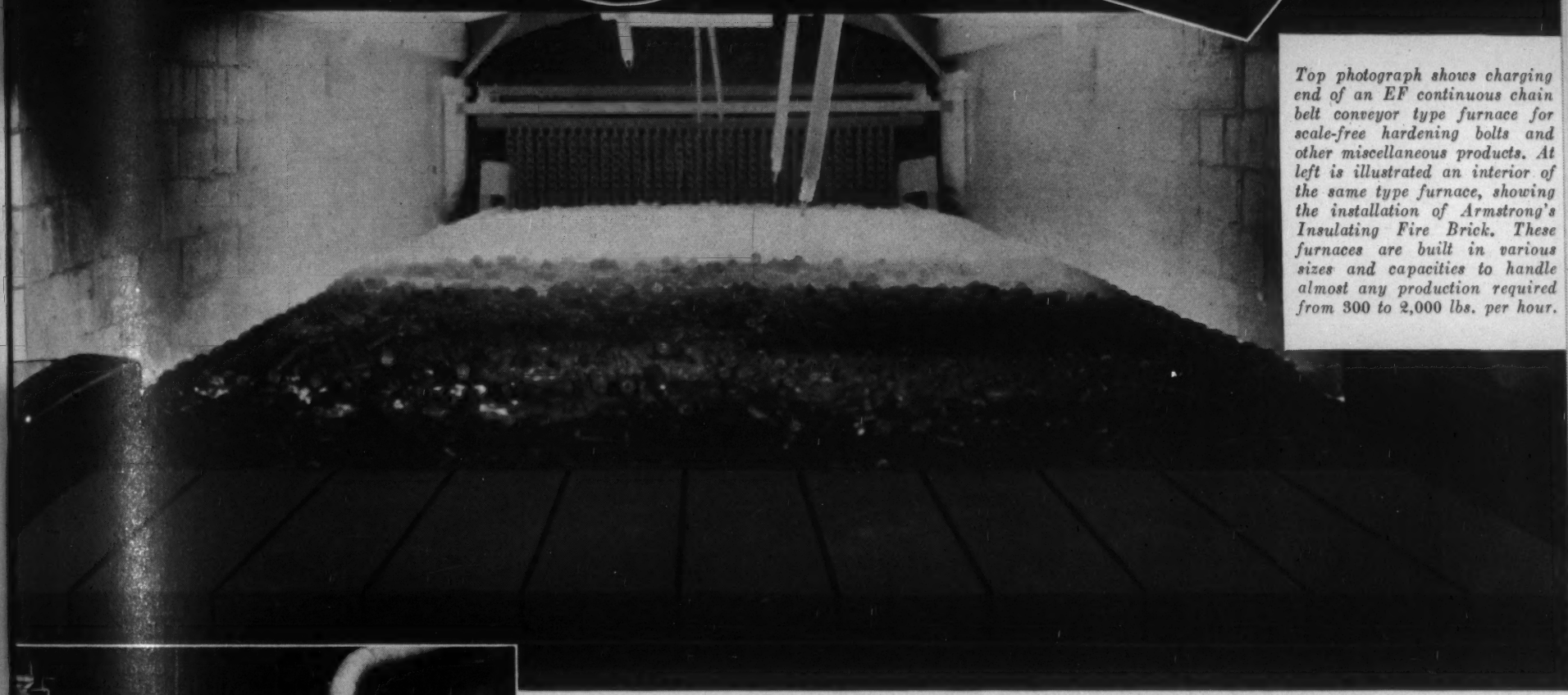
Lapix is applied to the top of the ingot head in the hot top immediately after pouring. It spreads over the exposed metal, forming an insulating blanket that, it is claimed, will keep the metal molten a sufficient time for gases to escape and enclosures to rise to the top. Also it is said that Lapix will materially reduce top discards, and definitely reduce porosity and secondary pipe where such tendencies occur.

(Continued on page MA 76)

ARMSTRONG'S BRICK

Cut fuel costs, help assure more uniform temperatures

IN THESE MODERN ELECTRIC EF FURNACES FUEL FIRED FURNACES

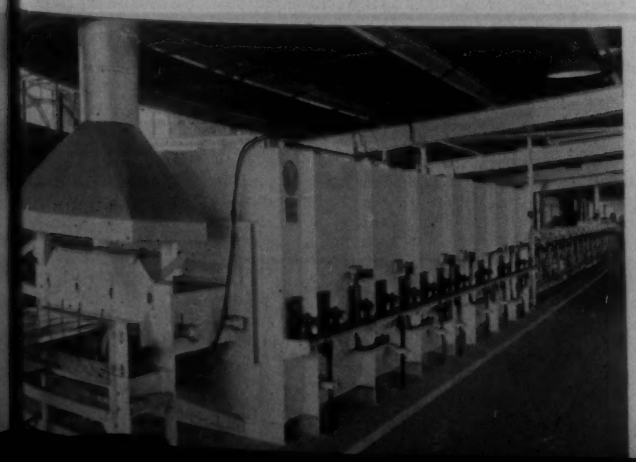


Top photograph shows charging end of an EF continuous chain belt conveyor type furnace for scale-free hardening bolts and other miscellaneous products. At left is illustrated an interior of the same type furnace, showing the installation of Armstrong's Insulating Fire Brick. These furnaces are built in various sizes and capacities to handle almost any production required from 300 to 2,000 lbs. per hour.

ve: This special atmosphere, continuous bright annealing furnace is of several gas fired, radiant tube furnaces recently placed in operation he Electric Furnace Co. It is insulated with Armstrong's Insulating Brick for maximum efficiency and economical operating costs.

~ ~ ~

ow: Charging end of an EF continuous atmosphere electric fur- for bright annealing cold rolled steel in strip form. Like the other ces shown here, it has the efficient insulation of Armstrong's Brick.



DESIGNED and built by The Electric Furnace Company, Salem, Ohio, these furnaces have the efficient, money-saving insulation of Armstrong's Insulating Fire Brick.

Chief among the advantages of Armstrong's Brick are: low thermal conductivity, high crushing strength, high spalling resistance, and lightness in weight. The exceptionally high insulating efficiency of these brick is the result of the fine cellular composition produced by burning out finely ground cork particles. Their use assures lower fuel costs, more accurate temperature control, and increased operating efficiency. That is why Armstrong's Brick are the choice of so many leading furnace manufacturers and plant operators.

For engineers wishing to make open specifications for high temperature insulation, Armstrong will gladly furnish complete specifications outlining the standards required for the different physical characteristics with permissible tolerances. Write today for samples, prices and descriptive literature. Armstrong Cork Co., Building Materials Div., 982 Concord Street, Lancaster, Pa.

IMPORTANT FEATURES OF ARMSTRONG'S BRICK

1. Ample insulating value
2. High crushing strength
3. Accurate sizing
4. High spalling resistance
5. High salvage value
6. Complete line for wide temperature range
7. Ability to withstand handling in shipping and installing
8. Special shapes of all types and sizes
9. Easily cut on the job
10. Stocks available in principal cities
11. Laying cements with same physical characteristics as brick
12. Complete line of refractory facing cements for protective coatings.

Armstrong's

HIGH TEMPERATURE INSULATION

INSULATING FIRE BRICK — **PLASTIC CEMENTS**

HIGH TEMPERATURE BLOCK — **DIATOMACEOUS EARTHS**

Die Blocks, Electrically Heated

The Cooley Electric Mfg. Corp., Indianapolis, Ind., has put on the market a pair of die blocks for forming thin metal discs under heat and pressure. These die blocks are formed by casting aluminum around an electric element which is formed of the usual wire coils, but which are embedded in a refractory that in itself is more than 50 per cent metal, yet has a high diaelectric. The heat from the coils is conveyed rapidly and uniformly to the surface of the block, because of the ceramic used.

The elements can be formed in a variety of shapes such as rectangular, cylindrical, or rods and the entire structure is sufficiently strong to permit machining after casting. Aluminum, brass, copper, and iron have been successfully used as the casting material.

Electric Heater with Water-Cooled Electrodes

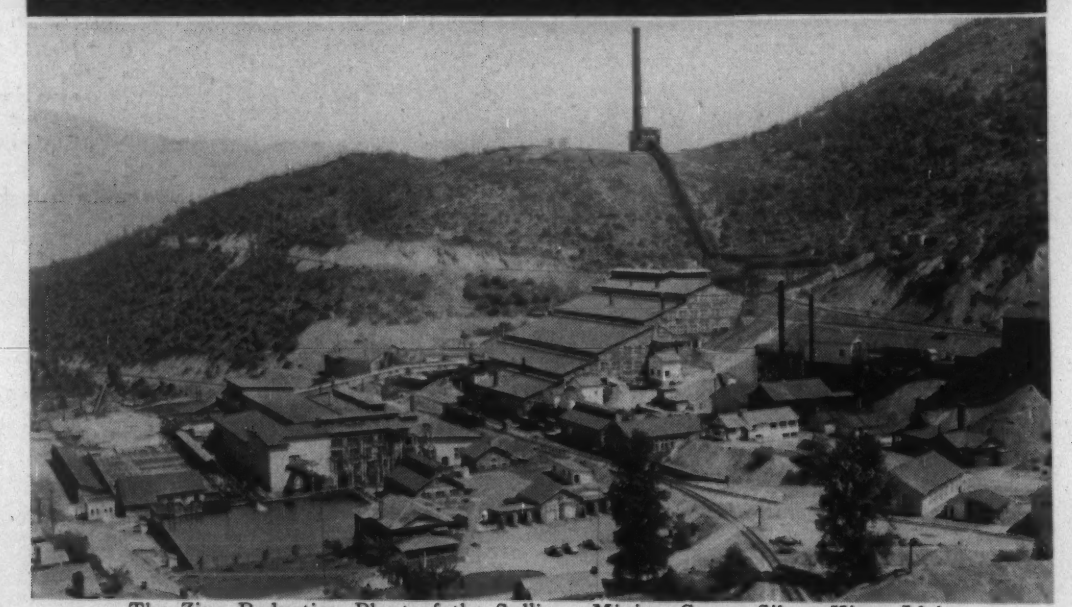
A line of Berwick electric heaters, comprising seven models which differ principally in capacity and in the number of electrodes used, has been introduced by the American Car & Foundry Co., New York. The Model, known as the No. 4 two-electrode type "LS" metal heater, is provided with low temperature electric eye for working down to 1100 deg. and up to 2300 deg. F. It is equipped with air cylinders for giving any desired pressure on the piece being heated. Electrodes are water-cooled. This type of heater may be used on both steel and non-ferrous metals, for upset and drop forge work. The range is from ¼ to 1½ in. in dia., and practically any length heat can be obtained from 1 up to 23 in.

Hydraulic Pump for High Test Pressures

A new motor-driven hydraulic pump, capable of developing pressures up to 30,000 lb. per sq. in. (2000 atmospheres), also a dead weight gage (free piston gage) for measuring the pressures developed, are announced by the American Instrument Co., Silver Spring, Md.

The pump is used for creating very high test pressures for determining bursting strength of cylinders and spheres; for operating high-pressure and hydraulic intensifiers; and for carrying out experiments to determine the effect of extremely high pressures and sudden release on various materials. Further details are available from the manufacturer.

10th ANNIVERSARY



The Zinc Reduction Plant of the Sullivan Mining Co. at Silver King, Idaho

BUNKER HILL COMPLETES 10 YEARS OF UNINTERRUPTED OPERATION

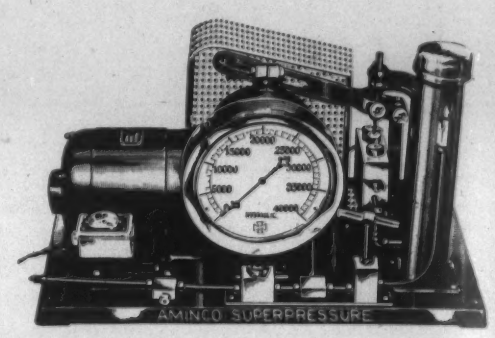
With the start of 1939 the Bunker Hill zinc plant completes ten years of uninterrupted operation. Bunker Hill pioneered the production of 99.99+% zinc and made it available to industry three years prior to the appearance of any comparable metal. New achievements in many industries were made possible; these ranged from practically revolutionary changes in the physical properties and applications of die casting, to increased flexibility and corrosion resistance of zinc coatings on galvanized strip and wire.

The extent of these changes can be demonstrated, for example, by the enormous increase in the use of zinc base die castings. In 1928 the die casting industry consumed 30,000 tons of slab zinc. Since Bunker Hill showed the way to the production of four-nine zinc in commercial quantities, the consumption of slab zinc by die casters rose to 88,000 tons in 1937 —the last figure available. In view of these achievements, rarely duplicated in the metal industry, the 10th anniversary of Bunker Hill is well worth noting.

99.99+%

ST. JOSEPH LEAD CO.
250 PARK AVENUE • NEW YORK
ELdorado 5-3200

BUNKER HILL ZINC



Rigid, Low-Resistance Lead Anode

Securus Lead Products Co., 6410 Detroit Ave., Cleveland, announces a new type of lead anode for chromium plating and other electrolytic processes (patent applied for). The advantages claimed are; unusually low electrical resistance, resulting in saving generator power; more even current distribution at all points of the active surface; and unusual mechanical rigidity against bending and warping.

The construction embodies a lattice type frame of strip copper, upon which is deposited and firmly bonded by a special process, a thin film of pure lead which serves as an integrally-homogeneous basis on which lead is built up to the desired thickness all over. Since all parts of the lead are supported by the highly conductive copper frame by lead-burning or other suitable means, low resistance and great rigidity are obtained at all points. A final treatment with a lead-burning flame consolidates the lead coating to maximum density and assures freedom from porosity and blowholes which might otherwise permit penetration of the solution to the copper itself—a defect not unusual when casting is employed. These anodes are made both in special sizes and to standard dimensions as may be required.

Better Magnet Wire

Eliminating the need for space-consuming protective coatings in many instances, Formex wire, a new and superior magnet wire announced by General Electric Co. at the 1939 winter convention of the A. I. E. E., New York, is insulated with a synthetic resin which is tougher and more flexible than the conventional enamel coatings. The new resin is of the polyvinyl acetal type, while ordinary enamel coatings are composed of drying-oil resins. Since Formex wire requires less space for insulation and protection, it gives the designer new opportunities to reduce the size of many products

Further, electrical properties are as good as those of ordinary enameled wires, and tests show that Formex wire is considerably higher in resistance to abrasion and to the common treating solvents. When severely twisted and then subjected to a temperature of 125 deg C. for 1 hr., ordinary enameled wire cracks but Formex wire is not affected, it is claimed.

Current Metallurgical Abstracts

EDITOR • EDWIN F. CONE

Assistant Editors
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1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2·REDUCTION

Blast Furnace Practice, Smelting and Electro-refining.

A. H. EMERY, SECTION EDITOR

The Preparation of Pure Metals of the Titanium Group by Thermal Decomposition of their Iodides. Part IV. Production of Lower Zirconium Iodides in the Preparation of Ductile Zirconium (Ueber die Herstellung der reinen Metalle der Titangruppe durch thermische Zersetzung ihrer Iodide. IV. Das Auftreten niedrigerer Zirkoniodide bei der Herstellung duktilen Zirkons) J. D. FAST. *Z. anorg. allgem. Chem.*, Vol. 239, Sept. 3, 1938, pp. 145-154. Research. Lower iodides of Zr are formed by overheating ZrI_4 in the presence of excess Zr. In the preparation of ductile Zr by heating ZrI_4, the rate of formation of Zr increases markedly at 250° C. Above 300° C. the rate decreases with further increase of temperature as a result of the reaction between ZrI_4 and excess Zr. It is likely that at 400° C. ZrI_4 reacts with Zr to form ZrI_3, while at 500° C. ZrI_2 is formed. Furthermore, above 310° C. ZrI_3 decomposes according to the relation $2\ ZrI_3 \rightleftarrows ZrI_2 + ZrI_4$, and above 430° C. ZrI_2 decomposes according to the equation $2\ ZrI_2 \rightleftarrows Zr + ZrI_4$. As a result of the reaction between ZrI_4 and excess Zr, it is not possible to obtain any further yield of Zr at 250° C. in a reaction vessel previously heated to 400° or higher. HFK (2)

2a. Ferrous

Distribution of Stock. J. P. DOVEL. *Steel*, Vol. 103, July 11, 1938, pp. 48-49. Practical. Angle of repose of ore dumped into blast-furnace over a bell valve is greater than that of coke. It is affected by speed with which valve is opened and amount of clearance between valve and its seat. If bell is opened at moderate speed, ore will start to flow as soon as valve begins to open and will flow gradually as bell opens to take its natural repose. Coke will not begin to flow until valve is almost wide open, when it will discharge rapidly and with a splash, having a flattening effect. This makes possible complete envelopment of ore charge by coke, which acts as a filter, preventing escape of fine ore as flue-dust. This, combined with a larger stock-line area than customary, reduces flue-dust loss to a minimum. Finer ore particles will be near peak of charge, leaving coarser particles near wall and through center. Finest ore can be used without excessive flue-dust losses. Gases will have same rate of flow and same temperature along wall and through center, thus exposing denser portion of ore charge (small particles) around the charge peak to extreme heat from both sides, and causing very rapid reduction of fine ore. Part of CO_2 would be eliminated quickly high up in furnace. The peak circle of ore charge should reach hearth and bosh in its hottest zone, which is on about the same level as tuyeres. Thus, there is a direct relationship between the peak circle of ore charge and diameter at tuyeres. Majority of existing blast-furnaces can be corrected by increasing stock-line diameter. Charging of furnace according to these principles requires an adequate inwall cooling system. MS (2a)

Value of Charcoal as Blast Furnace Fuel (Träkols värde för masugnsdrift) HILDING BERGSTRÖM. *Jernkontorets Ann.*, Vol. 122, No. 6, 1938, pp. 221-257. Original research. The quality of charcoal available to Swedish blast furnaces is becoming less uniform. Spruce charcoal may have a dry weight 10-30% less than pine charcoal; charcoal from slow-growth wood may have 40% higher specific gravity than that from fast-growth. Since fuels are purchased on a volume basis, these variations represent important cost factors. The size of the chunks is also important, since large chunks cannot be packed into as compact a volume as small ones, and for the same weight may vary as much as 40% in bulk volume. Rapid burning results in soft charcoal. Spruce, because it tends to retain its gases swells more than pine during burning. Weight instead of volume should be used as a basis for the sale of charcoal. Among tests suggested are moisture content, loss of weight of dried charcoal on heating under vacuum, rate of O absorption and P content. The latter test is especially recommended, as the cumulative results should finally show from what areas and under what conditions a low P content may be obtained.. HCD (2a)

Influence of Calcium Sulphide on the Viscosity and Melting Point of Blast Furnace Slags. L. TSYLEV. *Metallurg*, Vol. 13, June 1938, pp. 90-97. In Russian. Research. Both synthetic and natural slags were used. The synthetic slags contained 45.00-58.00% CaO, 23.50-38.00% SiO_2, and 6.00-29.80% Al_2O_3. Composition of the natural slags was 34.16-48.56% CaO, 33.44-35.40% SiO_2, 5.67-20.12% Al_2O_3, 2.18-5.40% CaS, 0.84-4.65% MgO, 0.19-6.94% MnO and 0.64-0.97% FeO. Viscosity was determined at 1600°, 1550°, 1500° and 1400° C. CaS was added in amounts of 0, 3, 5, 7, 9 and 11%. The viscosity of synthetic slags having $SiO_2/CaO = 0.7\text{-}0.8$ and $(SiO_2 + Al_2O_3)/CaO = 0.8\text{-}0.9$ is raised by addition of CaS. Up to 5% CaS changes the viscosity only slightly, but further additions increase it sharply. Addition of CaS to natural slags also increases the viscosity, but the relationship could not be derived because the curves had maximum and minimum values. A maximum viscosity of 19-20 poises was obtained at 10-11% CaS. The viscosity of synthetic slags with $SiO_2/CaO = 0.8$ and $(SiO_2 + Al_2O_3)/CaO = 1.0\text{-}1.20$ is raised by the addition of CaS. A maximum of 11 poises at 1500° C. and 20 poises at 1400° C. was observed for 9-10% CaS. A somewhat smaller viscosity rise was found on adding CaS to slags with $SiO_2/CaO = 0.85\text{-}0.90$ and $(SiO_2 + Al_2O_3)/CaO = 0.75\text{-}0.80$. For slags with $SiO_2/CaO = 0.6\text{-}0.7$ and $(SiO_2 + Al_2O_3)/CaO = 1.0\text{-}1.2$, the viscosity rises sharply from 4% CaS up, but at 10-11% CaS it remains almost constant. MnO and MgO decrease the viscosity. Addition of CaS lowers the melting point but the drop is not proportional to the amount of CaS added. BZK (2a)

Influence of Different Slag-Forming Materials on the Viscosity of Blast Furnace Slag (Einfluss verschiedener Schlackenbildner auf den Flüssigkeitsgrad der Hochofenschlacke) F. HARTMANN. *Stahl u. Eisen*, Vol. 58, Sept. 22, 1938, pp. 1029-1033. Original research. The viscosity of various blast furnace slags was determined by the Morgules method in which an alumina cylinder suspended from a wire is immersed in the molten slag contained in a crucible; as the latter is rotated at constant speed, viscosity is indicated by the torque of the wire. The softening range of the slags was also observed and an evaluation of the slags from the practical standpoint attempted. The effect of the components CaO, MgO, SiO_2, Al_2O_3, TiO_2, ZnO, ZrO_2, B_2O_3, CaF_2, K_2O and Na_2O was determined. The results are shown in iso-viscosity curves for different temperatures and compositions. SE (2a)

Physico-chemical Principles of Sintering Krivoi Rog Iron Ores. S. ROSTOVTSEV. *Teoria i Pract. Met.*, No. 6, 1938, pp. 3-9. In Russian. A wide range of sintering mixtures was studied microscopically and chemically. With ores carrying 8-10% SiO_2 and a fuel content of 4.5-5.5%, only ¼-⅓ of the SiO_2 present forms Fe silicate, so that the high reducibility of the ore is retained. The Fe_2SiO_4 reaction is reversible and the silicate decomposes partially under oxidizing conditions. Fuel particles larger than 3 mm. are disadvantageous, particularly in sintering poor ores. Ore fines also exert a detrimental action, particularly with poorer ores, of which fines less than 0.5 mm. should be excluded. Partial fusion of the sinter is required, but excessive fusion lowers the quality of the sinter. (2a)

Properties of Krivorog Agglomerate and Their Effect on Blast Furnace Operation. I. DAIKHES. *Stal*, Vol. 8, Apr. 1938, pp. 4-11. In Russian. Practical. The use of 45-66% agglomerate in the ore charge increased production from 929 to 1081 tons per day, increased the proportion of directly reduced Fe from 56 to 62% and decreased coke consumption. Best results were obtained with an agglomerate containing 25% FeO. HWR (2a)

The Steel-tube Hot Blast Stoves of the Pilsudski Works at Chorzow (Die neuere Entwicklung auf dem Gebiete der feuerfesten Sondersteine) W. KUCZEWSKI. *Stahl u. Eisen*, Vol. 58, Oct. 6, 1938, pp. 1086-1089. Practical. A new blast furnace with steel tube hot blast stoves has been in operation at the Pilsudski works at Chorzow. Operating results indicate the steel tube hot blast stoves to be very satisfactory. SE (2a)

Rotary Stuerzelberg Furnace Produces High Grade Iron. *Iron Age,* Vol. 142, Sept. 1, 1938, pp. 29-30. Practical description of process used in producing clean molten Fe in rotary furnace, using calcined pyrites from H_2SO_4 plant, and either coke, pitcoal or lignite as fuel. The unit, developed as a low-cost producer of pig Fe, using the same grades of ore and coke, cannot compete with a blast furnace because capacity of the rotary furnace is small and economy is handicapped by overhead cost and amortization. On the other hand, the Stuerzelberg furnace is very efficient for producing small quantities of Fe. Advantages of this process over the Renn process frequently used in Europe are cited.

VSP (2a)

Reasons for Short Life of Blast Furnace Slag Pots. A. G. KALASHNIKOV. *Teoria i Prac. Met.,* No. 6, 1938, pp. 45-46. In Russian. Research. Average life of pots furnished by 1 Russian plant is 10 days-1 month, though other plants can furnish pots lasting from 6 months to about 1 yr. All of them fail by cracking. Microscopic and chemical study showed their C and Mn contents to be the same, 3.4 and 0.5%, respectively, but Si varied in the range 1.36-2.53%, which was reflected in the size and distribution of graphite flakes. Too high Si content was held as the cause of cracking. To prevent it, a composition of 3.2-3.4% C, 1.2-1.4% Si and 0.6-0.7% Mn is recommended. (2a)

Refining Pig Iron with Furnace Dust. YA. SMOLYANITSKII & A. SMOLYANITSKII. *Stal,* Vol 8, Apr. 1938, pp. 11-17. In Russian. Practical. While tapping into a ladle, 2000-2500 kg. blast furnace dust per 50 tons of pig Fe was added on the spout or in the ladle. The reaction of the metal with the Fe_3O_4 in the dust decreased Si, Mn, S and C. The average analysis before and after adding the dust was C: before 4.30%, and after 3.91%; Si: 1.08% and 0.71%; Mn: 2.54% and 2.06%; and S: 0.059% and 0.038%. Increased production of 2.55% and higher quality pig Fe gave a saving of 94,500 rubles annually per blast furnace.

HWR (2a)

2b. Non-Ferrous

Blast Furnace Department at the Broken Hill Assoc. Smelters Proprietary, Ltd., Port Pirie, South Australia. Lead Smeltery Practice at the Broken Hill Assoc. Smelters Proprietary, Ltd., Port Pirie, 1937. J. C. HUGHES. *Proc. Australasian Inst. Mining Met.* No. 107, Sept. 30, 1937, pp. 157-187. The blast furnaces, their auxiliary equipment and current practice are described. The charge consists of 6600 lbs. sinter, 200 lbs. slag skulls, 200 lbs. Pb dross, and 760 lbs. coke. Sinter analyzes 42.8 Pb, 9.4 SiO_2, 13.7 FeO, 3.0 MnO, 8.0 CaO, 9.4 Zn and 2.0% S. Skulls analyze 7.0 Pb, 21.0 SiO_2, 26.4 FeO, 2.4 MnO, 9.9 CaO, 3.1 Al_2O_3, 16.0 Zn, 4.1 S and 1.8% Cu; they are added to recover their values, dilute Zn in new slag and, because of high melting point, prevent fusion in the upper part of the furnace. The Pb dross contains 71.6 Pb and 8.8% Zn. ZnO is the chief factor tending to form accretions. Typical slag analysis is 21.0 SiO_2, 27.8 FeO, 5.4 MnO, 13.5 CaO, 5.8 Al_2O_3, 21.0 ZnO, 1.3 S, 2.0% Pb and 0.25 oz. Ag. Fume analyzes 62.0 Pb, 0.2 Cu, 13.5 Zn, 5.5 S, 0.53 As, 0.075 Sb, 2.71 Cd, 4.9% Cl, and 1.0 oz./ton Ag. The sludge, made from the fume, is filtered, the residues going into the sinter and $CdCO_3$ being precipitated from the filtrate with soda ash. The precipitate assays 0.08 Pb, 8.24 Zn, 52.67 Cd, and 0.18% Cl. AHE (2b)

Refining Processes at the Broken Hill Assoc. Smelters Proprietary, Ltd., Port Pirie, South Australia. C. G. PAIN. *Proc. Australasian Inst. Mining Met.* No. 107, Sept. 30, 1937, pp. 189-204. Descriptive. Bullion assays 0.004 Cu, 0.24 As and 0.80% Sb; 48.6 oz. Ag and 0.049 oz./ton Au. As and Sb are removed in a softening furnace; the bullion assays 0.004 Cu, 0.001 As, 0.020% Sb; and 53.4 oz./ton Ag. Ag and Au are removed by Zn to give Pb containing 0.54 Zn, 0.0005 Cu and 0.020% Sb; this is dezinced by oxidation. Sb slag from the softener containing 0.003 Cu, 3.0 As, 9.0 Sb, and 78.0% Pb is enriched to 22% Sb and shipped. Slag from the dezincing furnace is returned to the blast furnaces. The liquid Ag-Au-Zn alloy from the desilvering kettle (16 Pb and 65% Zn; 5000 oz. Ag and 5 oz./ton Au) is retorted and the Zn re-used. The Doré Ag is electrolytically parted by the Balbach-Thum process to 999.8 fineness. Au is purified by the Miller process to 990 fine. AHE (2b)

Reduction of Nickel Oxides by Means of Carbon Monoxide. D. P. BOGATSKII. *Metallurg,* Vol. 13, Jan. 1938, pp. 84-90. In Russian. Original research. Ni_2O_3 was obtained by heating $NiNO_3$ to constant weight at 600° and NiO by reducing Ni_2O_3 at 115-120° with H. Reduction of Ni_2O_3 starts at 120-122° and NiO at 344-346°. Reduction was studied for 1, 2, 3, and 4 hrs. at 100, 200, 300, 350, 400, 500, 600, 700 and 800°. Also, for 1 hr. at 250° and at 900° for 1 and 2 hrs. Complete reduction to NiO occurs in 1 hr. at 225°. The complete reduction of Ni oxides with CO is accomplished in 1 hr. at 900°. (See also *Metals and Alloys,* Vol. 8, Dec. 1937, p. MA 726L/9. BZK (2b)

Electrolytic Manganese. S. M. SHELTON, M. B. ROYER & A. P. TOWNE. *U. S. Bur. Mines Rept. of Investigations* No. 3406, July 1938, pp. 3-16. A pilot plant to produce 15 lbs./day of electrolytic Mn and its operation are described in detail. The ore used analyzed 31.10 Mn, 0.68 Fe, 17.38 SiO_2, 0.09 $CaCO_3$, 3.56 $MgCO_3$, 1.54 Pb, 0.15 As, 0.14% Cu, trace of Ni and Co. Highly efficient leaching may be expected from a porous ore ground to —10 mesh; a dense ore requires finer grinding. No improvements were found over the methods described by Clevenger and Carron for reducing MnO_2 to MnO. Equipment for leaching and electrolysis is similar to that required for a low acid electrolytic Zn plant. Practically the same impurities must be removed to the same degree from the electrolyte. Simple cloth diaphragms are required. Assuming equal current densities, the number of cells or total cathode area required for electrolytic Mn, with respect to electrolytic Zn, is inversely proportional to the respective current efficiencies for the same capacity. Power required for electrolysis was about 3.6 kw.-hr./lb. of metal. Reagents for purification depend on impurities to be removed. The major reagent cost is for removal of Co and Ni. For the experimental plant, reagent consumption/100 lbs. electrolytic Mn was $FeSO_4$ 1.7, Na ethyl xanthate 2.0 and K pentasol xanthate 1.3 lbs. Leaching reagent (spent electrolyte containing 2½-3% H_2SO_4) is regenerated. Loss of acid depends largely on acid-soluble alkali metals in the ore; for the ore used it was approximately 20 lbs. H_2SO_4/100 lbs. Mn. Not more than 1 lb. SO_2/100 lbs. Mn was added to the catholyte feed tank to condition the electrolyte. The sulfite ion oxidizes to SO_4 and partly replaces leaching losses. After the "break-in" period, only S and NH_3 will be needed to replace losses in leaching and electrolysis. High concentration of $(NH_4)_2SO_4$ was used for 2 reasons: (1) With $(NH_4)_2SO_4$ concentration 100 g./l. or greater in the almost pure solution, there was less resolution of deposited metal and (2) high metal recovery necessitates low $MnSO_4$ concentration in the catholyte chamber; $MnSO_4$ is a relatively poor conductor of electricity, particularly at low concentrations; high $(NH_4)_2SO_4$ serves to reduce ohmic resistance and provides lower cell voltage and lower power consumption. $MnSO_4$ in the catholyte feed was limited to less than 70 g./l. in order to limit H_2SO_4 concentration of the anolyte and better protect the cloth diaphragms. Current efficiency was approximately 50%, as much as 70% for 24 hrs., and increased with continued operation. It is largely a function of electrolyte purity.

AHE (2b)

The Scientific Fundamentals of Tin Smelting III (Die wissenschaftlichen Grundlagen der Zinnverhütung III) JOSEF KLÄRDING. *Metall u. Erz,* Vol. 34, No. 21, 1937, pp. 556-558; No. 22, pp. 580-584. Original research. Chemically pure SnO was mixed with 25% of coke dust, pine soot, semi-coke, charcoal or brown coal, and heated in an atmosphere of N_2 in an electric furnace to 700°, 800°, 850° and 900° C. Coke dust did not react until 850° C., whereas the other materials gave good reductions at 800° C. Reaction rate increased with increased amount of reducing agent. The rate and temperature of reaction depend on the amount and composition of volatile matter given off. Previous degassing of the fuel at 1100° C. diminishes the reducing action. For Part II, see *Metals and Alloys,* Vol. 9, Jan. 1938, p. MA 8 R/6. PCR (2b)

Some Reductions of Columbium Pentoxide. N. KH. ABRIKOSOV. *Metallurg.* Vol. 13, Apr. 1938, pp. 9-14. In Russian. Original research. Reduction of Cb_2O_5 by H_2 or CO consumes so much reducing agent, even above 1500° C., that the process is of no practical value. Reduction with C at atmospheric pressure is possible above 1660° C.; lower temperatures require a vacuum. Below 1530° C., the finely ground C and Cb_2O_5 must be thoroughly mixed because the reduction takes place by the direct interaction of solid phases. Reduction with atomic H goes to completion without difficulty and requires no excess of H. BZK (2b)

Investigation of the Equilibrium of the Reaction NiO + CO ⇄ Ni + CO_2. D. P. BOGATSKII. *Metallurg,* Vol. 13, Feb. 1938, pp. 18-24. In Russian. Research. The equilibrium NiO + CO ⇄ Ni + CO_2 was approached both by reducing NiO and by oxidizing Ni. For the interval 500°-1100° C., K_p changed from 554.6 to 57.2 according to $\log K_p = \frac{1735.1}{T} + 0.49935$. Other values obtained were: $\Delta H_{298} = 58301.6$ cal., $\Delta F^\circ_{298} = 9352.85$ cal., and $S^\circ_{298} = 11.31$ cal./degree. BZK (2b)

Theoretical Considerations in the Methods for Electrolysis of Fused Salts (De teoretiska grunderna för de smältelektrolytiska förfarandena) GÖSTA ANGEL. *Tek. Tid.,* Vol. 68, Oct. 8, 1938 (Section *Bergsvetenskap*) pp. 73-79. A theoretical discussion of the electrolysis of fused salts of Al, Mg, Na, Li, K, Ca, Ba, Sr, Ce, and Be. Discusses conductivity of the pure salts and salt mixtures, decomposition voltage, electrode potentials, polarization and anodic effect, ampere efficiency, electrode arrangement and materials, and diaphragms. A comparison between pure electrothermic and electrolytic methods generally favors the latter. BHS (2b)

3 · MELTING, REFINING AND CASTING

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Heating Air for Foundries in Steel Recuperators. ALFRED SCHACK. *Hutnik,* Vol. 10, No. 6, 1938, pp. 313-320. In Polish. Review. A discussion of the heat value of fuel gases, depending upon the temperature of the air used, shows possible fuel economy of 25% with preheated air. Steel recuperators do not accumulate heat and permit use of high pressure burners that effect thorough mixing of the gas and air. A description of recuperative furnaces in use for 3-5 yrs. and capable of heating 1,500-25,000 cubic meters air per hr. to temperatures up to 850° C. is given. The heat efficiency reaches 85%. Service life is not shorter than that of Cowper furnaces. The highest temperature of the tubes is 1050° C., well within the safety limit. Fuels of low heat value can be used. JGT (3)

The Solution of Oxygen in Liquid Metals (Ueber die Sauerstoffaufnahme in flussigen Metallen) WERNER LANGE. *Z. Metallkunde,* Vol. 30, Aug. 1938, pp. 274-276. Experimental. A jet of O was blown onto a molten bath of Cu, so that the oxidation reaction rate was not controlled by the rate of diffusion of O to the gas metal surface. The rise in temperature of the melt was followed as a measure of the rate of the reaction. Under these circumstances the diffusion of O in the melt controls the rate of oxidation until the metal becomes saturated with gas. The same effects were noted with other metals which have an affinity for O, Pb, Sn, Ni, Mn and Fe, but no temperature rise occurred with Ag. GD (3)

Risers or Gates for Some Special Non-ferrous and Alloyed and High Test Iron Castings. C. BRISBOIS & A. E. CARTWRIGHT. *Trans. Am. Foundrymen's Assoc.,* Vol. 46, Sept. 1938, pp. 219-248. Experimental. Pouring castings directly through risers was found successful for many types of castings, of both non-ferrous metals and high test and alloy cast irons. The experiments were conducted on castings weighing from a few ounces to those weighing 2 tons. As the basic form of feeding head, a straight-sided, round-shouldered, short-necked feeding head was adopted. In the authors' plant probably about 50% of the jobs eligible for this method of molding are so produced. CEJ (3)

Material for Centrifugal Casting Mold (Werkstoff für Schleudergusskokille) *Giessereipraxis,* Vol. 59, Aug. 14, 1938, pp. 333-334. To obtain proper cooling conditions, special bronzes were developed as material for centrifugal molds, containing 3-11% Al and 15-5% Ni + Fe. For Fe molds, Al additions of from 1 to 10% are advised. When first used, the interior faces of such molds will be covered with a thin skin of Al_2O_3 that retards heat transition from molten metal to mold, preventing excessive stresses in mold and guaranteeing more uniform cooling conditions, thus increasing mold durability. GN (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

Method for Increasing Roof Life of Open Hearth Furnaces. A. GADBIN & I. WINESTEIN. *Teoria i Pract. Met.,* No. 6, 1938, pp. 17-19. In Russian. Cooling effect of the charging doors shifts the major portion of hot gas current towards the back wall of the furnace and through the rear downtake. This greatly concentrates the wear, so that the roof over the rear downtake fails far ahead of the roof as a whole. Original strengthening of these portions of the roof or patching them does not solve the problem completely. Front downtakes of 4 stationary furnaces were made 1100 x 2000 mm. in place of the original 1000 x 2000 mm.; the latter dimensions were kept for the rear downtakes. Without any changes in practice, the number of heats which could be obtained in these furnaces before roof failure were: 243 (stopped before failure), 331, 204 (stopped before failure) and 270, in place of the original 190, 147, 166 and 135 heats. This modification of downtakes also slightly increased the life of the front walls. (3a)

The Fundamentals of the Desulphurization of Pig Iron with Sodium Carbonate and Sodium Silicates (Die Grundlagen der Entschwefelung des Roheisens mit Soda und Natiumsilikaten) F. KÖRBER & W. OELSEN. *Stahl u. Eisen,* Vol. 58, Aug. 25, 1938, pp. 905-914; Sept. 1, 1938, pp. 943-949. Original research by means of extensive laboratory studies and plant tests. Na_2CO_3 alone is a superior desulphurizer in the absence of SiO_2 or Si in the pig Fe. The Na_2S thus formed is stable at 1300-1400° C. in the presence of the melt, and does not require $Na_2O.SiO_2$ to keep it dissolved in the slag. Even at low S contents, however, FeS tends to separate out of the melt, so that some desulphurization may occur without the formation of Na_2S. No other reducing agent than C is necessary to promote desulphurization. The presence of SiO_2 hinders desulphurization and results in a higher S content because part of the Na in the Na_2CO_3 is consumed in forming $Na_2O.SiO_2$. Nevertheless, the $Na_2O.SiO_2$ has some desulphurizing action since it may react to form some Na_2S, and because it tends to dissolve out FeS from the bath. Upon the formation of highly basic sulphide-rich slags, and as a result of the reducing action of the C, strong deoxidation ensues; with viscous acid slags the deoxidation is weaker. A subsequent addition of SiO_2 to a reduced basic desulphurizing slag has the strongest deoxidizing effect and with sufficient excess SiO_2 may even result in a Si reduction by means of Na_2S. In this case S pickup is less than when SiO_2 is originally present in the slag. The addition of oxidizers or undecomposed Na_2CO_3, as well as a large excess of SiO_2, will cause a S pickup. The desulphurizing action of $Na_2O.SiO_2$ increases at higher temperatures. SE (3a)

Content of Ferrous Oxide in Open Hearth Metal Depending on the Basicity of the Slags and their Oxidation Value. P. N. IVANOV. *Metallurg,* Vol. 13, Apr. 1938, pp. 21-30. In Russian. Original research. The use of slags of high basicity raises the FeO in the metal; the FeO increases much faster than CaO/SiO_2. The increased FeO is due to a low Mn concentration and to the increased partial pressure of the CO, which is dissolved in the metal under the influence of the highly viscous slags. The failure of the slags to remove the S and P may be partly compensated by the addition of bauxite to raise their fluidity. Differences between the theoretical and experimental FeO are due to the fact that the analytical determination of FeO gives only the FeO that is in equilibrium with C and other elements. The non-equilibrium FeO escapes fixation because of the high speed of reaction in the homogeneous liquid phase, and has no practical effect upon the quality of the metal. BZK (3a)

Melting of Gray Iron in the Electric Furnace (Ueber das Erschmelzen von Grauguss im Elektroofen) O. GLASER. *Giesserei,* Vol. 25, Sept. 9, 1938, pp. 454-457. The electric furnace is particularly advantageous for the production of high-grade cast Fe of fine-lamellar pearlite and uniformly distributed fine-flake graphite. The former is obtained by controlling the composition and rate of solidification; the latter depends on mass, as well as on superheating of the melt. The most popular method in the electric furnace is to make a "synthetic" cast Fe from a liquid charge of low C content that is increased in the furnace by addition of charcoal, pieces of electrode C, coke, etc.; section of the furnace and size of the added pieces also have a certain influence on carburization. The different melting methods and the improvement of the mechanical properties of cast Fe by heat treatment are discussed. Examples of castings and their properties are described. 9 references. Ha (3a)

Use of Chromium-nickel and Chromium-molybdenum Scrap in Acid Electric Arc Furnaces. YU. SHULTE. *Stal,* Vol. 8, Apr. 1938, pp. 56-62. In Russian. Practical. The results of 850 heats corresponding to S.A.E. 3415 and X4130 steels are summarized. The charge consisted entirely of Cr-Ni and Cr-Mo steel scrap. The slag during the oxidation period contained approximately 50% SiO_2, 25% FeO, 15% MnO and 7% Cr_2O_3. By maintaining a high temperature during the oxidation period, Cr oxides in the slag and metal are reduced by C. The macrostructure and mechanical properties of the acid steel were superior to basic electric steel and consumption of ferro-chrome was reduced 65%, Ni 75% and ferro-molybdenum 75%. HWR (3a)

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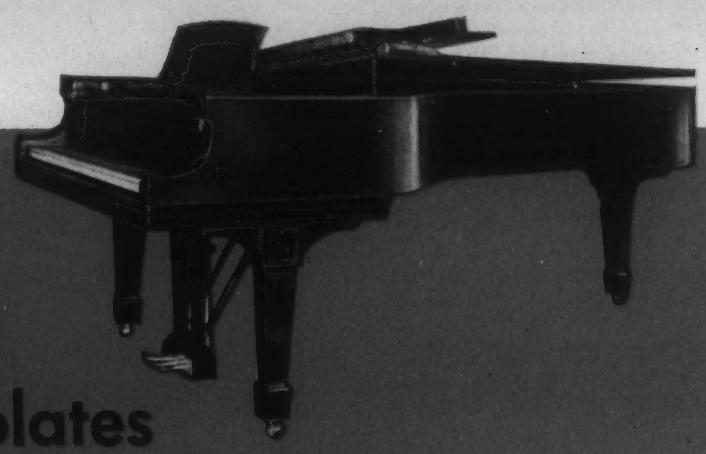

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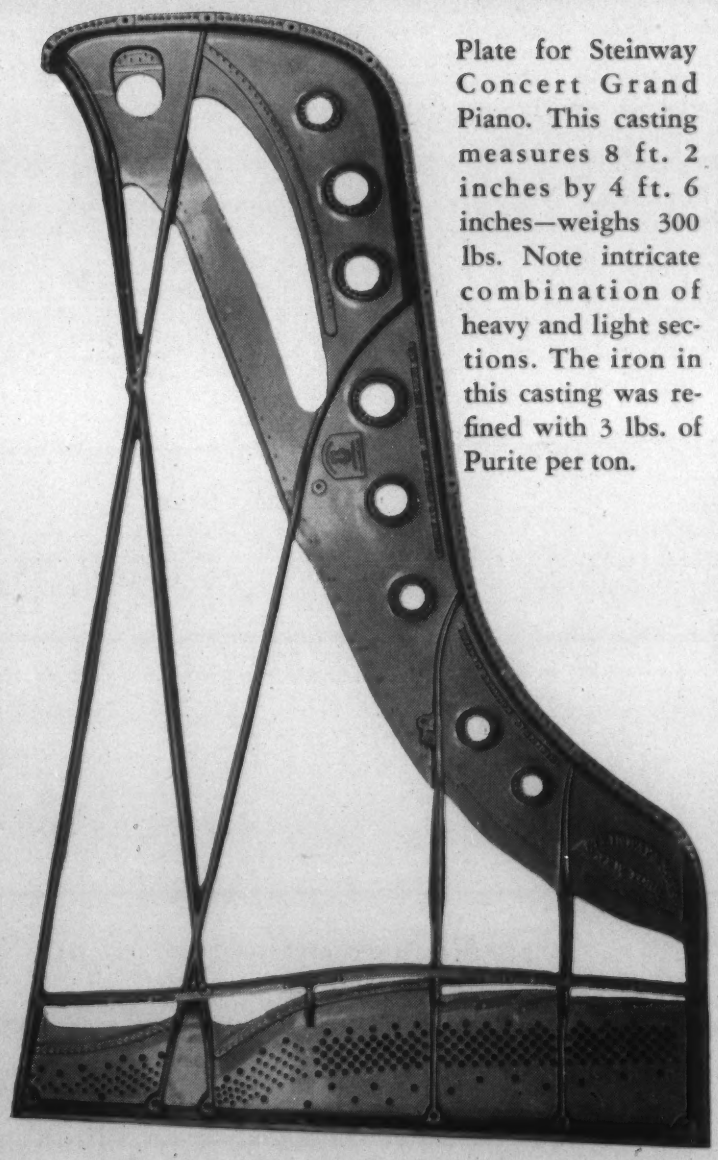

Plate for Steinway Concert Grand Piano. This casting measures 8 ft. 2 inches by 4 ft. 6 inches—weighs 300 lbs. Note intricate combination of heavy and light sections. The iron in this casting was refined with 3 lbs. of Purite per ton.

PURITE THE SCIENTIFIC FLUX, FOR BETTER MELTING AND CLEANER IRON

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Open-hearth Control. M. J. BRADLEY (Leeds & Northrup Co.) *Steel,* Vol. 103, Aug. 29, 1938, pp. 34-36, 60. Review. Discusses change in methods of operating open-hearth furnaces during recent years, and benefits derived from application of automatic control equipment. As a result, many furnaces produce at present a better quality of steel at about half the average of 6,400,000 B. t. u. used to produce a ton of ingots in 1928-1929. Some furnaces built during past year and furnished with means for controlling pressure, reversal, roof temperature, and fuel-air ratio are using several 100,000 B. t. u. less per ton even than above figure. Comparison of before-and-after costs of operation on a number of installations using various combinations of control instruments shows average savings of 9% in tonnage, 12% in refractories and 8% in fuel. MS (3a)

"Short Cycle" Pearlitic Malleable Iron (Ueber perlitischen Schnelltemperguss) R. GNADE, E. PIWOWARSKI & W. FELIX. *Giesserei,* Vol. 25, Sept. 23, 1938, pp. 469-473. Research. By systematically changing C-, Si- and Mn-content, the composition of a material that can be malleablized in a very short time, with a principally pearlitic structure independent of rate of cooling, was found. The composition was 2.4% C, 0.6-0.7% Si, 0.7-0.8% Mn; the best cooling rate was 80°-100°/hr. Tensile strength 85,000-100,000 lbs./in.^{2}; elastic limit 57,000 lbs./in.^{2}; and elongation 1.5-2%. Melts with up to 1.5% Ni showed, in spite of finer temper C, not much better mechanical properties. Ha (3a)

Cooperation between Founder, Designer and Shopman (Die Zusammenarbeit zwischen Giesser, Konstrukteur und Bearbeitungsfachmann) H. JUNGBLUTH. *Giesserei,* Vol. 25, Sept. 9, 1938, pp. 442-447. Cooperation on the basis of selecting the correct material for a given purpose, designing the piece correctly so that the foundry can turn out a sound casting, and also designing it correctly from the machining point of view, is emphasized, and proper procedures are illustrated by examples. 7 references are given for selection of material, 32 for design for foundry purposes and 2 for machining. Ha (3a)

Conditions Necessary for the Production of High Quality Medium Carbon Steel. A. DUDAR. *Stal,* Vol. 8, Apr. 1938, pp. 18-23. In Russian. Practical. A study of 1000 open hearth heats showed that the quality of the steel was best if (1) the oxidation period lasted at least 2 hrs.; (2) the average rate of C oxidation was 0.004-0.006%/min., decreasing to 0.002-0.004% at the end of the oxidation period; and (3) if the Mn content did not drop below 0.30% during the heat. HWR (3a)

3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Melting and Casting—Common Difficulties and Their Elimination by Modern European Practice. Part I. EDMUND R. THEWS & W. FROELICH. *Can. Metals Met. Inds.,* Vol. 1, July 1938, pp. 198-200. Review. The difficulties in the melting and casting of non-ferrous alloys and some successful and unsuccessful means of elimination are discussed. Alloys discussed include: Common brass, bronze sand castings, gunmetal, phosphor bronzes and Sn bronzes. **Part II.** *Ibid.,* Sept. 1938, pp. 249-250. High-Ni brasses subjected to a superheating temperature of about 210° F. above casting temperature under a layer of charcoal were definitely weaker than the same metal superheated beneath a flux cover. This condition is due to the presence of excess of C. Most of the failures obtained with Ni brass castings are due entirely to faulty methods of melting and alloying. Remelting of gunmetals results in even more beneficial results than are obtained in remelting high-Ni brasses. Correct packing of the different parts of the charge, a minimum of stirring, and the renewal of the C cover at not too frequent intervals are important features of Ni brass remelting. WHB (3b)

Sand Control in Non-ferrous Foundry Practice. G. K. EGGLESTON. *Foundry Trade J.,* Vol. 59, Sept. 29, 1938, pp. 236-238. Descriptive. Grain distribution, rather than average grain size, is the governing factor of casting finish. The permeability is dependent upon the per cent of voids and the surface area of the grains. The strength and durability of a sand depends upon the species of clay and the size of the particles, not the total clay content. The re-use of floor sweepings by screening and removal of fines can greatly reduce the quantity of new sand used, in some cases about 50%. AIK (3b)

Experimental Production of Oxygen-free Copper by Remelting with Boron Slags. M. P. SLAVINSKII & M. SH. KHASKHOZEV. *Metallurg,* Vol. 13, Apr. 1938, pp. 15-20. In Russian. Practical. The boron slag was prepared by melting a powdered mixture of 4-5% Mg and 95-96% $Na_2B_4O_7$. About 2-4% of this slag is necessary to completely deoxidize Cu that contains a small amount of O_2. To obtain O-free Cu, the metal should be superheated to 1300°-1350° C., be in good contact with the slag, and be isolated from the air during pouring. BZK (3b)

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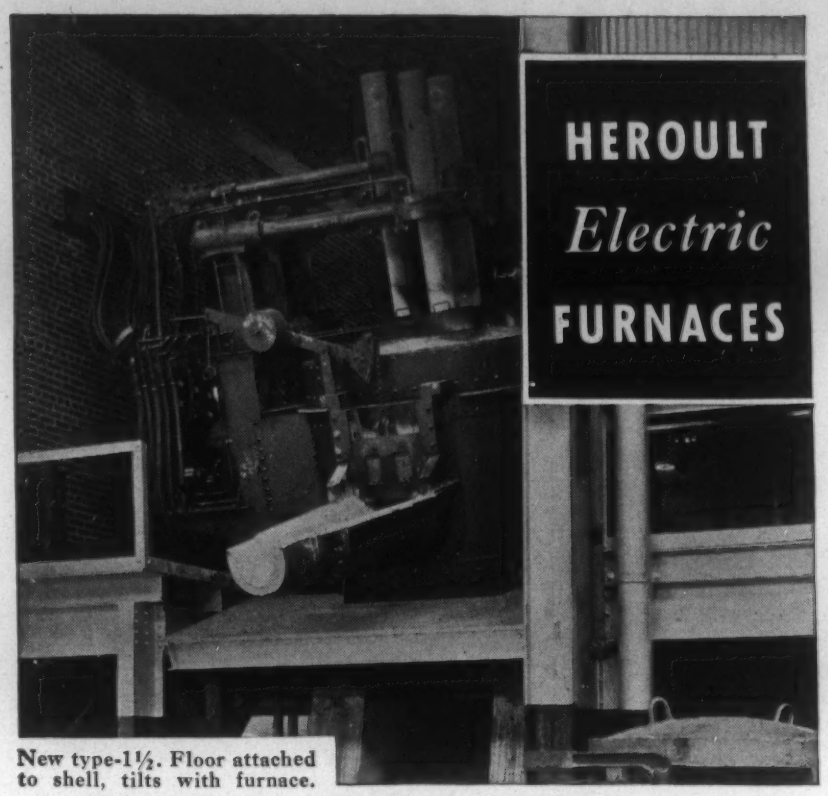
Non-ferrous Castings. The Proper Use of Runners and Risers. F. DUNLEAVY. *Metal. Ind., London,* Vol. 53, Sept. 23, 1938, pp. 294-302. Discussion of several difficult problems encountered in casting bronzes and Al. In casting an Al plate 3 ft. 6 in. by 3 ft. 1 in. by 1½ in., good castings were produced only after 2 risers were put in the center of the plate. A large amount of heat is lost in the ordinary riser or feeder by contact with the atmosphere and sand. By pouring small P-bronze castings in a rather unorthodox manner (4 to a feeder) the hottest metal is found just at the spot where it is required, at the joint of the runner and casting. If these 4 castings were run in the usual manner, considerable waste would have been involved. The temperature would have had to be very closely controlled because, if too low, the block casting would be drawn at the runner and, if too high, a very spongy patch would be expected on top of the casting. Mn-bronze or high tensile brass demand special treatment when cutting runners or risers. They have the habit of drawing in the most unlikely places. Very often running in the top part instead of the bottom may eliminate this defect. Wet sand or too liberal use of the swab will cause bad patches in this area. Casting at too high temperature or poor design will cause these defects. Dross in castings is usually due to poorly designed runners. All risers for Mn-bronze must be cut so that the neck of the riser is as short as possible, otherwise a badly drawn place can be expected. A long stream of metal must be avoided in pouring, or scummy metal will be formed. No attempt should be made to force the metal in the mold. In casting Al it is advisable to use a number of wide and thin ingates in preference to one large one. The advantage of this is that the casting temperature can be lowered considerably, and solidification commences almost immediately. RWB (3b)

Production and Properties of Age Hardenable 5% Nickel-bronze Castings. T. E. KIHLGREN (Internat. Nickel Co., Inc.) *Trans. Am. Foundrymen's Association,* Vol. 46, Sept. 1938, pp. 41-59. Practical. The properties and foundry production of an age hardenable Ni bronze of moderate cost and broad utility are presented; the composition is 88% Cu, 5% Ni, 5% Sn and 2% Zn. The mixture possesses physical properties somewhat superior to those normally obtained for 88-10-2 bronze in the "as-cast" condition and, in addition, can be age hardened to secure the following range of properties: 70,000-90,000 lbs./in.^{2} tensile strength, 50,000-74,000 lbs./in.^{2} yield point, 25-5% elongation, and 140-200 Brinell hardness. The effect of modifications of the normally employed heat treatment are discussed. Pb is a highly objectionable impurity, and as little as 0.05% will seriously retard age hardening and also cause hot cracking if the castings are cooled rapidly from the 1400° F. "solution treatment." Si retards aging, but the effect of small amounts of Si (0.05-0.10%) can be neutralized to a certain extent by a moderate increase in the aging temperature and in the Ni content (to 5.5%). The effects of other impurities are briefly discussed. The foundry procedure recommended for castings to be age hardened differs from that considered good practice in 88-10-2 bronze, chiefly in the oxidation of the Cu-Ni melt with cuprous oxide (or other suitable oxides) and a subsequent reduction with P, prior to the addition of remelt and the introduction of Sn and Zn. Where heat treatment is not contemplated, or maximum response to heat treatment is not required, the oxidation treatment may be omitted, and melting merely carried out in a moderately oxidizing atmosphere. The oxidation treatment, however, has been found definitely to increase the response to age hardening and to be generally helpful. CEJ (3b)

Die Castings Gain Ground in Hardware Production. HERBERT CHASE. *Iron Age,* Vol. 142, July 21, 1938, pp. 33-36; Aug. 4, 1938, pp. 42-44. Practical discussion of die casting technique used by Yale & Towne Mfg. Co. The first instalment considers chiefly the intricate dies employed in multiple cavity work. Sections as thin as 0.015 in. are cast between movable cores in some instances. Wherever feasible, several parts of the same assembly are produced in the same die; this practice sometimes yields as many as 20 small castings in a single "shot" of the casting machine. All dies are hardened to maintain the degree of accuracy required when parts have relative motion. The second instalment deals with subsequent machining operations on small, cored lock plugs. Unusually well illustrated. VSP + FPP (3b)

"Frostiness" in Plumbers' Solder. C. H. S. TUPHOLME. *Can. Metals Met. Inds.,* Vol. 1, Oct. 1938, p. 284. "Frostiness," often associated with inferior metal, can be produced on the surface of a bar of otherwise good quality solder by casting into an overheated mold or by the presence of Zn, Al or Cd. This effects a coarser structure than that produced by pouring into a cool mold. Examination of test joints and the results of pressure tests show no evidence of poorer quality for the coarse grained solder. There is no connection between what the plumber considers the working properties of the solder and the quality of the joint. WHB (3b)



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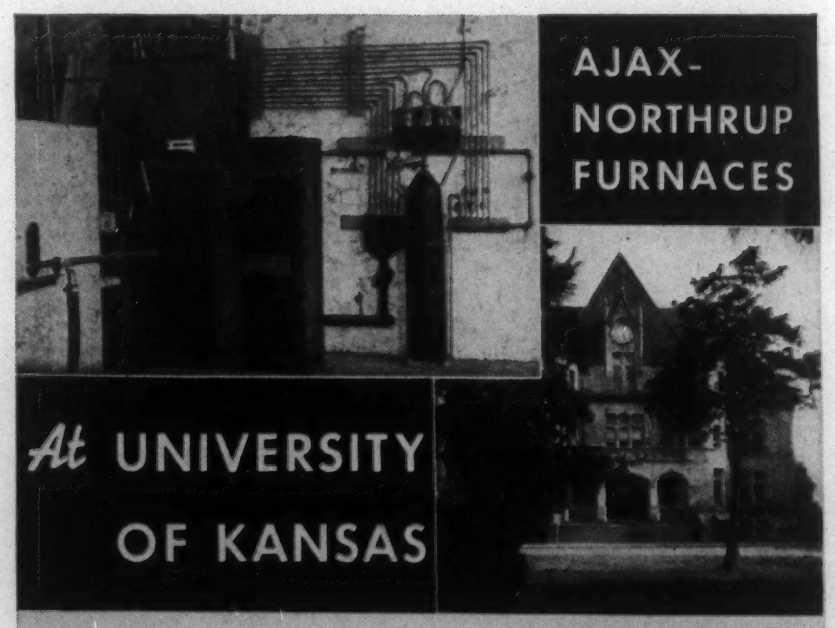

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New Applications for Press Work. Part I. Replacement of Parts Now Made by Other Methods. J. D. JEVONS. *Metal Ind., London,* Vol. 53, Oct. 21, 1938, pp. 389-392. Review dealing with new applications for drawn and pressed parts. Increasing application may be anticipated in all kinds of engineering components, domestic and utilitarian articles, all manner of containers, ranging from large vessels in "clad" material to collapsible tubes and tiny capsules, cowls and fairings for aircraft, panels and other members for road vehicles, and ordnance work. The replacement of the whole articles or component parts, hitherto cast, by either one piece, Cu-brazed, or welded multi-piece pressings with consequent saving in both weight and cost, is already under way. Pressed and drawn steel parts of sufficient thickness may be case hardened and used to replace many parts hitherto machined from the solid. A combined inlet and exhaust manifold for a 4 cylinder automobile engine is an example of a replacement in which, although the cost of production of the built-up article may not be less than that of the casting, other advantages render the built-up pressed steel product preferable. This manifold represents a 63% weight-saving over the cast manifold, and the smooth internal surfaces and accurately-spaced and dimensioned openings increase the engine efficiency. Pressed and drawn parts can be welded together, to replace heavier and more expensive methods of fabrication, often with an increase rather than a decrease in strength and rigidity, although the cost of large press tools can only be met by a guaranteed output of a large number of pressings. RWB (D-4)

Increasing Angle of Bite in Rolling and Improvement of Rolled Stock Quality. A. CHEKMAREV. *Teoria i Pract. Met.,* No. 6, 1938, pp. 28-34. In Russian. The angle of bite and the initial maximum reduction can be increased to 35° and 55%, respectively, by shaping the periphery of rolls as a many-sided polygon with smoothly curved sides. An extensive mathematical treatment supports the theoretical aspects of the proposal, and some experimental work shows its commercial advantages. The desired shape is given to the rolls on a copying lathe. (D-4)

4a. Ferrous

Rope Wire. W. R. BLOXDORF (Macwhyte Co.) *Wire & Wire Prod.,* Vol. 13, Oct. 1938, pp. 505-515, 617. Comprehensive review. High tensile strength is not the only important quality expected of rope wire; ductility, toughness, resistance to deformation and fatigue resistance are also required. Production of satisfactory cold drawn steel wire for wire rope depends on selection of composition and raw material (wire rod); correct heat treatment; correct manipulation (cleaning, coating, baking, and subsequent cold drawing) of heat-treated material. Each of these factors is discussed. Most rope wire in modern use is made from fully-killed open-hearth (acid or basic) steel, although a small amount of low-C rimmed steel is used in producing the weakest grade of rope wire. The strongest grade ("Improved Plow Steel") of rope wire contains 0.65-0.85% C and must have a tensile strength of at least 230,000 lbs./in.^{2} Coarse to medium-grained "normal" steels are preferred. Preliminary patenting of hot rolled rods before drawing is advocated, particularly if the C content be over 0.55%. Patenting produces a uniform coarse-grain structure consisting of fine lamellar pearlite with a minimum of free ferrite. Direct electric resistance patenting of 0.128-in. 0.67% C stock is described. The resistance patenting produced a great improvement in fatigue strength as compared with that of wire patented in conventional gas-fired furnaces. Other properties of satisfactory rope wire are discussed. Ha + FPP (D-4a)

The Machining of Mn Steel. *Machinery (London),* Vol. 52, Sept. 22, 1938, pp. 757-762. Practical. Although the 12% Mn steel has a hardness of only 180-210 Brinell after water quenching from 1050° C., special high speed steels and tool design as well as a rigid set up are necessary to avoid cold working the surface of the steel, which makes machining impossible. JZB (G-4a)

Manufacture of Large Forgings. WM. J. MERTEN. *Ind. Heating,* Vol. 5, Oct. 1938, pp. 923-928. Practical. Discusses character of steel (acid or basic open hearth) for forging ingots; type of mold; casting of ingot to avoid cold shuts, shrinkage cavity, etc.; heating for forging, and soaking pit practice; hot pressing and the individual forging operations; annealing; and testing. In the example described, the corrugated ingot was stripped from the mold at 1200° F. after 42 hrs., heated to 2200° F. for 48 hrs., then top-end-rounded and body-roughed to 58 in. The ingot was then heated to 2100° F., held in the furnace for 18 hrs., subjected to the second forging operation, heated slowly to 2200° F., held there for 20 hrs., given the third forging operation, heated at 2300° F. for 8 hrs., given the fourth forging operation, heated at 2250° F. for 8 hrs., then finish-forged. The forging was then placed in the furnace, heated at 1600° F. for 24 hrs., cooled slowly to 1300° F., reheated at 1600° F., cooled slowly to 200° F., and allowed to cool in air. Mechanical properties of samples of the finished forging were: Tensile strength, 77,500 lbs./in.^{2}; yield point, 39,000 lbs./in.^{2}; elongation in 2 in., 21-26%; reduction of area 41%. Ha + FPP (D-4a)

The Cold Deformation and Recrystallisation of Metal Crystals with Particular Reference to Alpha-iron. J. W. RODGERS. *J. Iron Steel Inst.,* Advance Copy No. 13, Oct. 1938, 17 pp. Original research. An X-ray examination of the recrystallizing properties of single crystals and polycrystals of α Fe showed that the tendency of metal crystals to recrystallize after cold deformation is greater if the deformation takes the form of compressive strains, such as cold rolling, than if it takes place in tension. A tentative theory is put forward in which the supposition is made that there are 2 types of plastic flow: (1) Easy flow along the normal glide directions, which does not change the mechanical state of the metal to any great extent; and (2) difficult flow, which takes place across the normal glide directions and causes a considerable rise in the internal energy of the metal; this is accompanied by an increased tendency to recrystallization and a considerable increase in penetration hardness. Tensile stresses promote easy flow and compressive stresses difficult flow. This theory fits in with certain experimental observations on grain growth after cold deformation. Practical applications of the theory are discussed. JLG (E-4a)

Construction and Operation of the First German Wide-strip Mill (Bau und Betrieb der ersten deutschen Breitbandanlage) F. WINTERHOFF. *Stahl u. Eisen,* Vol. 58, Nov. 3, 1938, pp. 1225-1238. The development of wide hot and cold continuous strip mills in the United States and Germany are compared and a new 1300-mm. (51-in.) wide mill of this type built in Germany, with a capacity of 40 to 60,000 tons a month, described. American design appears to be followed fairly closely. SE (E-4a)

4b. Non-Ferrous

Plastic Hot and Cold Forming of Light Metals—Rolling, Forging, Pressing, Drawing (Plastische Warm- und Kaltverformung von Leichtmetallen, Walzen, Schmieden, Pressen, Ziehen) *Tech. Blätter,* Vol. 28, Sept. 25, 1938, pp. 566-568. A survey of present-day German practice of forming light metals and their respective alloys, such as Al and Al alloys, including Al and Cu clad light metal alloys. Particular points to be observed in extruding, rolling, forging, drawing and roll forming are stressed. Heating and annealing furnaces are briefly considered. GN (E-4b)

Advances of the Forged Piston (Der geschmiedete Kolben im Vordringen) ERICH KOCH. *Deut. Motor Z.,* Vol. 15, May 15, 1938, p. 172. Original research. In comparison with the cast light metal piston, forging furnishes considerably higher strength and toughness without impairing the running qualities. Microstructures of a forged duralumin type piston and of an Al-Si alloy are shown. The latter has been perfected as a forging recently. EF (D-4b)

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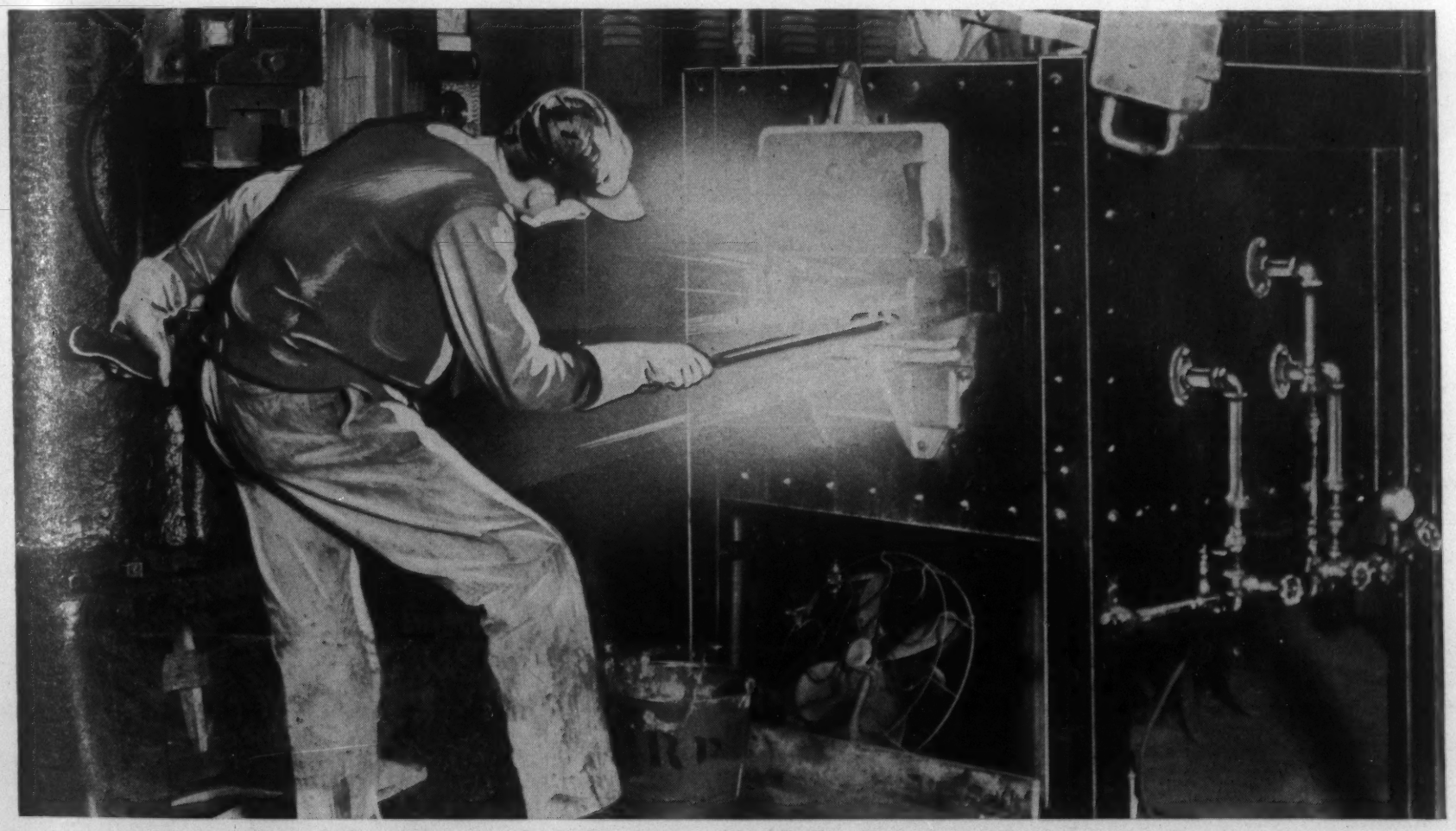

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Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.

O. E. HARDER, SECTION EDITOR

Temperature Uniformity in Combustion Chambers. M. H. MAWHINNEY. *Ind. Heating,* Vol. 5, Oct. 1938, pp. 906-913. Practical. In a previous article (see *Metals and Alloys,* Vol. 7, Dec. 1936, p. MA 584 R/10) the author demonstrated that the size of a combustion chamber should be based on a heat liberation between 7 and 10 B.t.u./ft.^{3} of chamber volume, and that the total port area from the chamber should be based on a maximum liberation of 400 B.t.u./in.^{2} of port area. The relative dimensions of chamber width, length and height to obtain this volume, particularly as they affect temperature uniformity, are discussed in the present article. Minimum height should be 7½ in. for combustion chambers less than 48 in. long, and 12½ in, for chambers longer than 48 in. Burner block should be set flush with the inside of the wall to reduce the size of the hot port, which is not balanced by a similar hot area at the other end. Ports should be graduated in size from one end to the other, with largest areas at the burner end, to balance the effect of flame velocity from the burners. A graphical summary of numerous tests on furnaces of different dimensions and operating at different temperatures gives approximations for port distribution in furnaces of various designs. Furnace design should be such as to permit changing the distribution of ports with a minimum of difficulty. Ha + FPP (5)

Bright Annealing Plant. A Hood Type Electric Furnace. *Metal Ind., London,* Vol. 53, Oct. 28, 1938, pp. 421-422. Description of commercial installation. The plant is designed to handle small metal parts, particularly those requiring special treatment for magnetic properties. The parts are in a completely machined condition, and the anneal is purely to reduce their retentivity to a minimum. The plant consists of the furnace, switch gear, temperature control and ammonia dissociator. The furnace comprises a cylindrical cover, which can be raised or lowered by means of a crane, and 2 fixed bases each having a gas tight hood. Each base is used alternately, reducing the time between anneals, thus increasing the capacity. Heating elements are provided, both in the cover and the base, so that the charge, which is contained in a basket, surrounds the center heater and is heated almost entirely by direct radiation. The gas tight hoods fit closely over the center heater base and are rendered gas tight by oil seals. A "neutral" atmosphere of H_2 and N_2 is obtained from cracked ammonia and a special burner. RWB (5)

Recent Developments in the Field of Special Refractories (Die neuere Entwicklung auf dem Gebiete der feuerfesten Sondersteine) F. HARDERS. *Stahl u. Eisen,* Vol. 58, Oct. 6, 1938, pp. 1081-1085. Review. Magnesite bricks have been applied because of their resistance to temperature changes and their retention of strength at high temperatures. Recently, a porous magnesite brick has been used in highly stressed portions of open-hearth furnaces. In the U. S. the production of unburnt magnesite brick has been growing. Unburnt chrome-magnesite brick with very good properties are also produced in the U. S. Chrome-silica and chrome-alumina brick have been utilized, but so far not in Germany. Work is being done in the U. S. and Germany on magnesia-silicate brick. 31 references. SE (5)

Performance and Types of Electrically Heated Continuous Furnaces (Wirkungsweise und Bauformen elektrisch beheizter Durchlauföfen) A. SCHAU. *Elektrotech. Z.,* Vol. 59, June 2, 1938, pp. 577-580; June 9, 1938, pp. 608-611. The conditions of heat transmission in a furnace are discussed at length. A calculation of temperature and temperature distribution in furnace and work is easier in a continuous than in a batch furnace. Examples for low and high temperature furnaces for small parts, strip and bright-annealing are described. Ha (5)

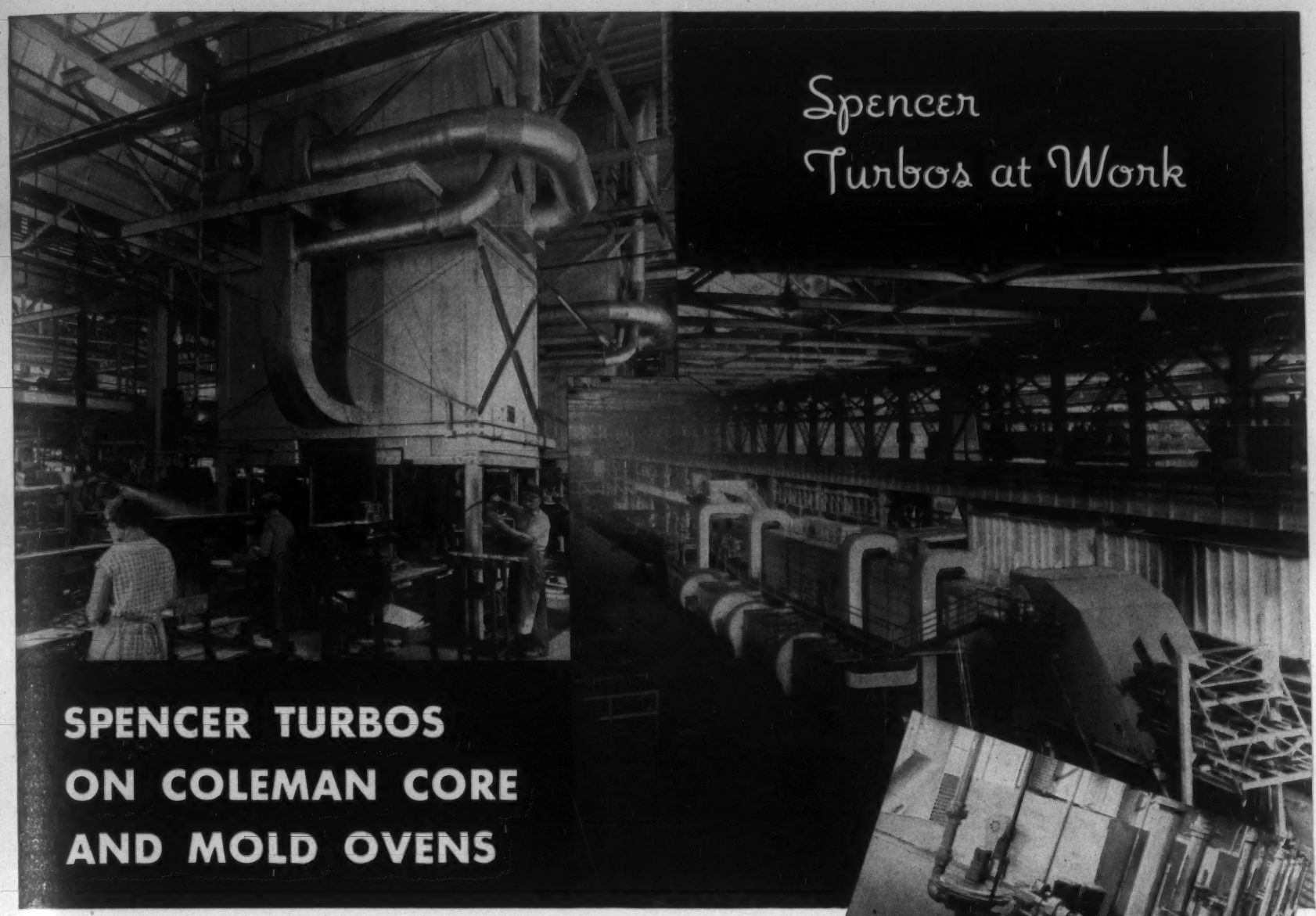
Determination of Temperature Distribution in Solid Bodies. W. TRINKS. *Ind. Heating,* Vol. 5, Oct. 1938, pp. 901-904. Discussion of a set of German graphs and tables on the cooling processes of simple hot bodies. The data simplify the finding of the temperature distribution in solids and the heating and cooling in steel and in furnace walls. Examples illustrate the practical application of some of the curves to problems in furnace design and application. Ha (5)

Practical Advantages in the Use of Special Refractories. H. E. WHITE. *Ind. Heating,* Vol. 5, Oct. 1938, pp. 945-952; Nov. 1938, pp. 1061-1063. Original research. Special refractories are termed those consisting essentially of the crystalline materials: Fused alumina, mullite and silicon carbide; the first and last are made in the electric furnace, while mullite is usually converted from kyanite, sillimanite and andalusite by heating at high temperatures for long periods. The melting points of some refractory materials are: Magnesia 2800° C., silicon carbide 2300° (dissociates), alumina 2050°, chromium oxide 1990°, mullite 1810°, silica 1713°; the specific gravity of fireclay (fired flint clay) is 2.55-2.75, crystalline alumina 3.91-4.01, mullite 3.03-3.10, silicon carbide 3.17-3.22. High grade refractories should contain at least 85% of either of the last 3 minerals. The various products on the market are discussed, and causes of failure by erosion and slag action described. Fused alumina refractories are preferably used where high temperatures and high bearing loads are combined (piers and supports). Mullite bricks have a high resistance to spalling and volume stability, and are used extensively in the glass industry, due to their low solubility in molten glass, and in metallurgical furnaces for their high strength and slag resistance. Bonded silicon carbide has proved extremely suitable for muffle furnaces for hardening high speed tools, mainly because of their high heat conductivity, thus giving a more uniform temperature. It is non-spalling and, therefore, used for hearth tiles and linings, to give longer life and greater economy. A curve is included to show the most economical time to replace the lining. Ha (5)

Characteristics of Fuel Oil and Their Effect on Furnace Design. D. A. WHITEHEAD (Shell Co. of Australia) *Heat Treating Forging,* Vol. 24, Aug. 1938, pp. 407-414. The characteristics of fuel oil are listed and its storage, handling, burning, vaporization, and atomization, characteristics of the flame produced and their application to metallurgical furnaces are discussed. Flame characteristics are: Liberation of a large quantity of heat in a small space, strong luminosity, large size and high temperature. These properties make oil fuel suitable for melting metals with high melting point in open-hearth, rotary and crucible furnaces. When melting metals of lower melting point in cast-Fe or cast-steel baths or pots, heat must be conveyed from flame to bath at a controlled rate and properly distributed. This can be done by propagating flame clear of bath itself and carrying hot gases around bath surface, or by having flame directly beneath bath, but interposing a thickness of refractory between bath and flame. Most applications of fuel oil in the metallurgical field, such as heat treating, require much lower temperatures than can be obtained in the oil flame. Heat transfer from flame to work must be adjusted so that the required temperature can be maintained in working chamber. There are a number of ways of doing this, some of which are discussed. These include situating flame some distance from work, and placing refractory between flame and work. For low temperatures, such as found in a mold stove, excellent results can be obtained with forced circulation. MS (5)

Practical Aspects of Controlled Atmosphere Annealing in Electric Tunnel Furnaces. J. MARLL. *Metal Treatment,* Vol. 4, Spring 1938, pp. 3-8. General discussion on choice and maintenance of controlled atmosphere furnaces. With a new furnace, tests should be made with a travelling thermocouple to determine the temperature gradient, the settings of the gas control valves determined, and routines established for securing the requisite dryness of the gas and freedom from S. Oil and grease must generally be removed from the work by pre-cleaning, preferably by trichlorethylene followed by a dip in boiling alkali. JCC (5)

The Processes in Electrode Saltbath Furnaces (Ueber die Vorgänge in Elektrodensalzbadöfen) K. A. LOHAUSEN. *Elektrowärme,* Vol. 8, Nov. 1938, pp. 283-288. Detailed description. The recent developments in 3-phase furnaces of the salt bath type, and the progress made by arranging the electrodes in such a manner that the useful bath space is kept large, uniform movement of the molten salt maintained, and uniform temperature distribution obtained, are discussed. These furnaces are used extensively for case-hardening as well as for simple heating in neutral salts. Ha (5)



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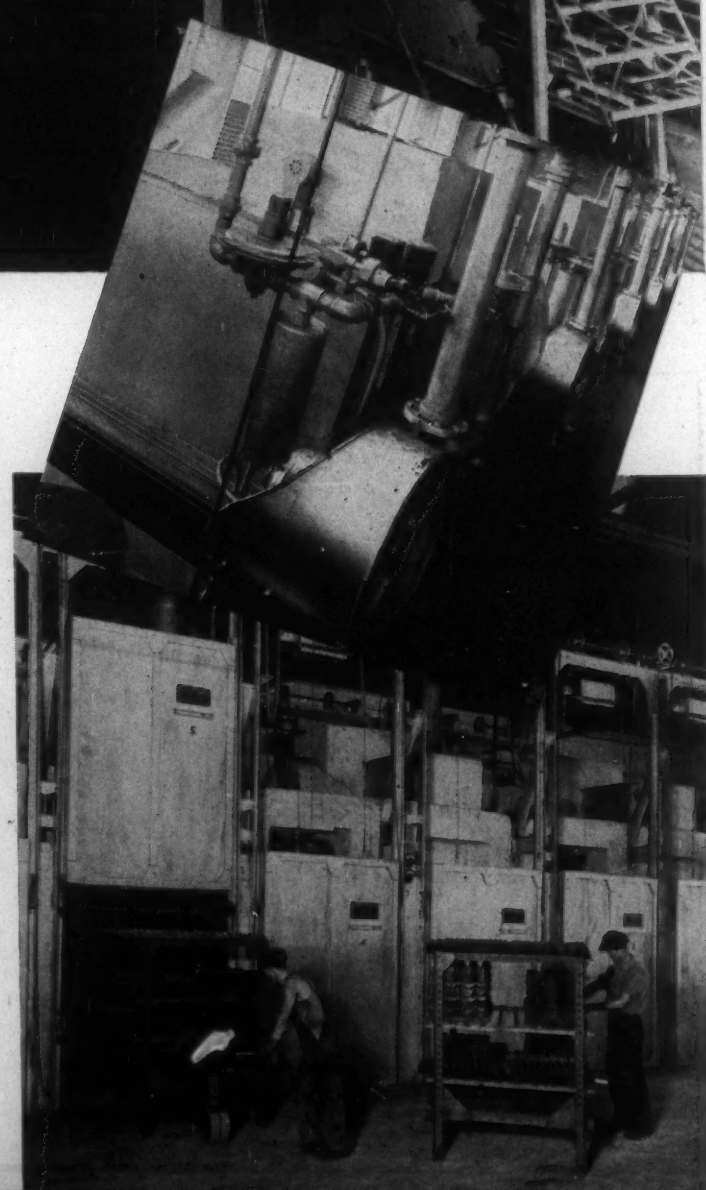

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Innovations in Electric Furnaces (Neuerungen an elektrischen Öfen) *Tech. Blätter,* Vol. 28, Aug, 14, 1938, pp. 373-374. Description of a number of useful innovations in electric melting, annealing and heat treating furnaces, such as (1) a Siemens & Halske induction furnace with an arrangement of the annular hearth that makes possible tapping without current interruption, (2) Russ furnace with a special device for generating effective bath circulation, (3) AEG coreless induction furnace equipped with a non-magnetizable screen between induction coil and furnace shell to avoid its superheating, (4) coreless induction furnace by Hirsch Kupfer- u. Messingwerke, with an induction coil surrounded by a yoke effecting concentration of current flow upon the metal bath, (5) new type of continuous electric strip annealing furnace possessing separate heating elements that guarantees uniform heating throughout, (6) a Krupp continuous bright annealing furnace applying a controlled atmosphere, (7) a circular rotating hearth furnace for heating ingots and the like, and (8) a method to stop convection currents in electric bright annealing furnaces. GN (5)

5a. Ferrous

O. E. HARDER, SECTION EDITOR

Coiled Silicon Strip Steel. BURTON LONGWELL (Republic Steel Corp.) *Iron Age,* Vol. 142, Sept. 22, 1938, pp. 52-53, 82. Practical description of the advances made in the manufacture of coiled Si steel. Some of the developments are: A new annealing process so that the product would lay flat when uncoiled, and a method of restoring to the steel the desired electrical properties that were destroyed by cold strip rolling process. The Si steel is used in thickness of from 0.025 to 0.014 in. In cold working, which is necessary to get down to desired finish gage, the highly strained steel loses its electrical properties. Solution to above problems was the development of a new technique consisting of pulling ribbons of strip at a predetermined speed and temperature through atmosphere-controlled roller hearth furnaces. This gives the strip a uniform anneal and removes destructive effects on electrical properties. Another important feature of this annealing technique is that the oxide produced on Si strip is of a different nature from that produced on Si sheets. Considers the advantages of using coiled Si strip. VSP (5a)

The Quench-ageing of Steel. J. H. ANDREW & E. M. TRENT. *Iron Steel Inst.,* Advance Copy No. 1, Oct. 1938, 48 pp. Original research. Experiments were made to determine the effect of C upon the rate and magnitude of aging, as measured by increment in Vickers hardness. Aging was brought about by quenching the normalized steels from temperatures below the Ac_1 point. The effect of small additions of Si, Mn, Al and Mo were also determined. The method used was to carburize pure Fe in acetylene gas, along with pure Fe to which the special elements had been added. The carburized bars were sectioned by cutting them at such an angle as to allow a large number of hardness impressions to be taken between the carburized surface and the center of the bar. In nearly all cases the maximum increase in hardness at 25° C. occurred in a zone corresponding to a C content of approximately 0.035% after quenching from just below Ac_1. This C content corresponds to the amount regarded as the limit of solubility of C in α Fe. The addition of Mn up to about 1.0%, or the same amount of Mo, decreased the aging. Si up to 0.88% produced but small differences, while Al up to 0.47% brought about a decrease in hardening on aging. Nitrogenized Fe, after quenching from certain temperatures, gave a much greater increment in hardness than Fe-C alloys. Nitro-martensite, unlike martensite in Fe-C alloys, showed considerable aging at room temperature. The view is expressed that the increment in hardness produced by aging is due to the strain in the lattice produced by carbides of Fe or nitride of Fe, prior to their precipitation from solid solution. JLG (5a)

New Hardening Process for High Speed Steel. *Steel,* Vol. 103, Aug. 22, 1938, p. 46. Industrial note. New liquid carburizing method, called Valcase, has been developed by Chapman Valve Mfg. Co., Indian Orchard, Mass. Uses a fused salt-bath mixture [composition not stated] readily melted in ordinary pot furnaces without excessive fuming or smoking. Case depths range from 0.015 in. obtained in 30 min. to 0.045 in. obtained in 4 hr. Working range of bath is 1450-1700° F. Recommended operating temperature is 1650° F., although maximum case depths can be secured at 1700° F. One advantage claimed is that parts, when withdrawn from bath without quenching, may be readily machined, then reheated and quenched. Other advantages include uniform depth and hardness of case, rapid penetration, no corrosion of finished parts, fluidity of bath at operating temperature, high impact and wear resistance values, gradual merging of case with core, and no pitting or decarburization. MS (5a)

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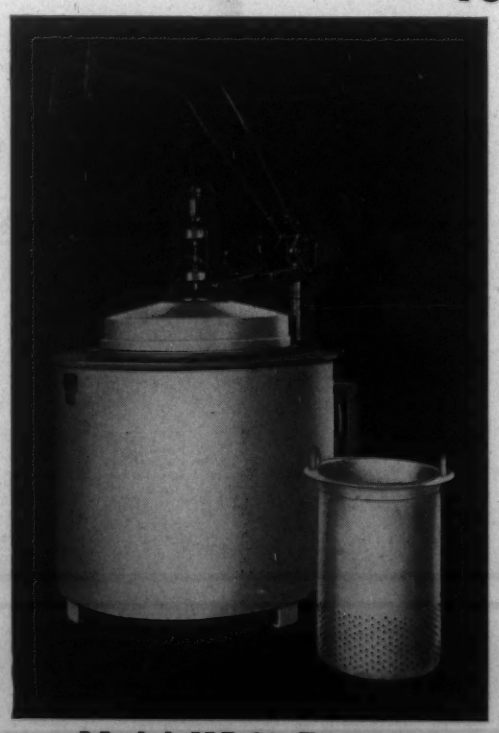

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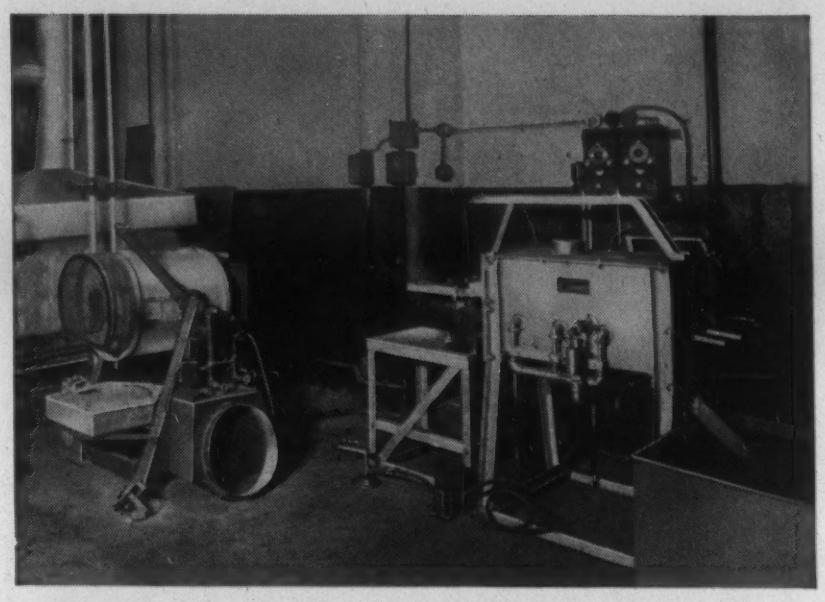
Effect of Cooling Velocity on the Transformations and Properties of Vanadium Steels (Einfluss der Abkühlungsgeschwindigkeit auf die Umwandlungen und die Eigenschaften der Vanadinstähle) F. WEVER & A. ROSE. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch, Düsseldorf,* Vol. 20, No. 16, 1938, pp. 213-227. Original research. Two V-steels with 0.5 and 1.0% V and 0.3-1.7% C, cooled at different cooling velocities, were thermally and micrographically examined. Undercooling diagrams are shown. Three undercooling stages can be distinguished: In the first stage, for cooling velocities up to about 20°/sec., the pearlite transformation is reduced to about 600° C., precipitation of V-carbide is suppressed, and ferrite and cementite precipitation is unchanged. The structure shows transitions from ferrite-pearlite mixtures to "sorbite" in the hypoeutectoid steels, from coarse spheroidal cementite to "sorbite" in eutectoid steels, and "sorbite" and cementite needles in hyper-eutectoid steels. Hardness increases rapidly with cooling velocity. The second stage starts from about 15° C./sec.; the eutectoid ferrite precipitation is suppressed, the temperature of the austenite precipitation drops from about 525° C. at low C contents to about 450° at 1.5% C, and is independent of cooling velocity. This stage is always connected with recalescence and characterized by needle-like structures similar to martensite but quite distinct from the pearlite of the first stage. The hardness decreases in the hypoeutectoid and eutectoid steels, and increases in the hyper-eutectoid steels with increasing cooling velocities. Stage 3 is the martensite stage and covers the total transformation process. The temperature of the martensite transformation is the same as in C steels and independent of cooling velocities. The structures of the martensite stage do not differ essentially from those of unalloyed steels; the martensite is usually very fine. The hardnesses increase in this stage with increasing cooling velocities to a maximum of about 900-950 Vickers units. A decrease occurs again at very high velocities because of the increasing amount of untransformed austenite. The behavior of V steels at higher cooling velocities lies between the C steels and the high-alloy Cr-Ni steels. 12 references. Ha (5a)

Heat Treatment by High Frequency Induction. L. C. CONRADI (Internatl. Business Machines Corp.) *Metal Progress,* Vol. 34, Sept. 1938, pp. 214-217. Discussion of the benefits derived as to the saving in time in the heat treatment of small parts by the induction method. The quenched spark gap high frequency unit is used on a 60 cycle 220 volt line, and produces sufficient power at the working coil end to quickly heat small machine parts to temperatures above their critical for annealing and hardening operations. Case carburized parts can be hardened by this method. Induction heating offers the additional advantage that it is possible to use a 0.40-0.50% C steel and alloy steels for many gears and cams instead of a low C carburizing grade, and thus eliminate the costly selective case hardening operation. In all instances, induction heating produces a minimum amount of scale on the parts treated. Selective hardening is possible, owing to the fact that the primary or working coil can be so placed as to heat the particular spot to be hardened. [The last sentence can be explained further by saying that the metal part to be hardened, when placed within the working coil, virtually short circuits the induced current within the coil and causes a sufficient number of eddy currents to be set up within the metal in this area to raise its temperature to above its critical point. Therefore, only the metal within the coil becomes heated to the high temperature, the adjacent metal being heated by conduction only. A thermocouple could not be used in this case, owing to the electrical field set up, but the experienced operator could judge the temperature of the metal part by eye.—C. W. H.] CWH (5a)

The Influence of Low Temperatures on Quenched EI173 and EI184 Steels. N. MINKEVICH, O. IVANOV & YA. DOVGALEVSKII. *Stal,* Vol. 8, Apr. 1938, pp. 63-65. In Russian. Original research. EI173 (1.10% C, 0.25% Si, 0.4% Mn, 2.38% W, 0.81% V, 9.20% Cr) and EI184 (0.98% C, 0.62% Si, 0.4% Mn, 4.08% W, 1.56% V, 8.68% Cr) steels contained 50-60% retained austenite after oil quenching from 1200° C. Cooling below 0° C. transformed this austenite into martensite, the transformation being almost complete in 3 min. at —70° C. The austenite remaining at —70° C. was high in alloy content, and further cooling to —183° C. would not transform it. The specimens after cooling were subject to aging at 100° C., which increased their hardness about 2 units Rockwell C. HWR (5a)

Stress Relieving and Preheating. W. G. THEISINGER (Lukens Steel Co.) *Iron Age,* Vol. 142, Oct. 13, 1938, pp. 131-132, 134, 136, 138; Oct. 20, 1938, pp. 22-25. Practical discussion. Points out some of the problems of present day welding, describes welded specimens prepared to study the effect of stress relieving, and lists the experimental data obtained. Considers also the effect of stress relieving on hardness and microstructure, and residual stresses in welding heavy plate sections. Includes a number of graphs and photomicrographs. Steels used were S.A.E. 1035 and 150. VSP (5a)



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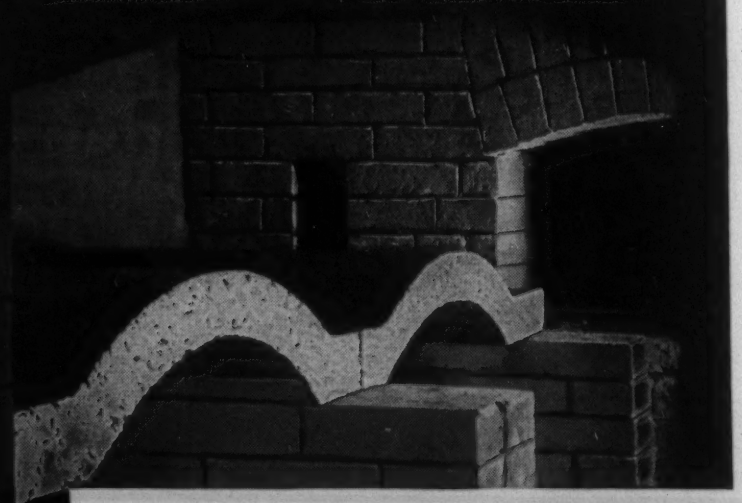

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Oxyacetylene Surface Hardening. A. K. SEEMANN. *Mech. Eng.*, Vol. 60, July 1938, pp. 535-540. A flame-hardening process may be applied to any ferrous material that will respond to simple heating and quenching to develop hardness. The procedure is described in detail, and the advantages summarized as: Equipment is in instant readiness; simple straight C steels or low alloy steels can be used; operation is rapid; only the surface is hardened at exactly the desired place; depth can be varied; the size of the piece is immaterial; there is little tendency to distortion; and the portable equipment can also be used for flame softening. Ha (5a)

Chisel Steels and Chisels. L. SANDERSON. *Machinery (London)*, Vol. 52, Aug. 11, 1938, p. 579. Summary of chisel steels used in England:

No.	% C	% W	% Cr	% V
1	0.70–.95	....	....	....
2	0.70–.95	....	....	.20
3	0.45–.60	....	.80	.20
4	0.55–.70	....	.50	....
5	0.45–.55	2.0	1.25	.25
6	not given	....	....	....
7	.....	14.0	....	....
8	.....	14.0	% Ni	....
9	.....	....	2.75	....

No.	Forging Temp., ° C.	Hardening Temp., ° C.	Tempering Temp., ° C.	
1	870–760	760–800 W.Q.	175–290	
2	870–760	760–800 W.Q.	175–200	
3	900–760	790–815 W.Q.	175–200	
4	900–760	790–815 W.Q.	175–200	
5	925–760	900–925 O.Q.	230–290	
6	1000–800	850–900 Air	500–550	
7	1000–1050	850–870 Oil	500	entire tool (pneumatic chisel)
8	.....	900–1000 Oil	.....	point
9	950–1000	900–950 Oil	.....	hand chisel

JZB (5a)

Lightweight Refractories. L. W. BERTELSEN (Armstrong Cork Prod. Co.) *Steel*, Vol. 103, Oct. 3, 1938, pp. 44, 46. Descriptive. Car-type furnace for heat treating rolling-mill rolls is 35 x 10 x 12 ft. high. Side walls consist of an average of 11 in. of insulating fire-brick, backed with an average of 7 in. of another type of insulating fire-brick, inclosed in a steel shell. An arch of similar construction uses 9 in. and 4½ in. of the respective types of brick. The furnace has been fired to 2150° F. maximum and is held under positive pressure with neutral or slightly oxidizing atmosphere. Reducing atmosphere is sometimes used. In the usual cycle, the furnace is brought to 2000° F. about every 3 weeks and held for 2½-3 days. The temperature is then reduced to 1500° F. within 6 hrs. The charge is withdrawn and temperature is dropped to 1000° F. within 15 min. The inner surface was given a glazed finish by applying a clay that glazes at about 2200° F. This increases the furnace efficiency, owing to the radiation from interior walls and by sealing the furnace to prevent heat losses from air infiltration. Tests have shown that the temperature of the walls is lower than that of the charge. Fuel saving, compared with furnaces formerly used, is more than 45%. Temperature difference in any part of the furnace is less than 10° F., assuring uniform heating of entire length of rolls, some of which weigh as much as 100,000 lbs. During the flood, the furnace was submerged to a depth of 11 ft., but the walls were found to be intact in every respect after the waters receded. After 4 years' continuous operation, the furnace is fit for many years' more service. MS (5a)

Surface Hardening of Steel by Heating with High-frequency Current (La Trempe Superficielle de l'Acier par Chauffage au Moyen de Courants à Haute Fréquence) G. BABAT & M. LOSINSKY. *Rev. gén. élec.*, Vol. 44, Oct. 22, 1938, pp. 495-510. Review. The skin effect exerted by high frequency current in solid metals is utilized to heat steel (shafts, cylinders, large, solid pieces in general) by placing them in a magnetic field of high frequency formed by inductively arranged water-cooled coils. The general laws of induction heating and the current distribution in the interior of the steel are explained and the energy expanded by the Foucault current calculated; the optimum conditions for heating are determined for different shapes, and an installation using a vacuum tube generator is described. Ha (5a)

Diffusion Annealing of Flake-sensitive Steel. E. A. KLAUSTING. *Metallurg*, Vol. 13, Mar. 1938, pp. 55-61. In Russian. Original research. Diffusion annealing for 20 hrs. at 800° C. (directly after forging) was found sufficient for complete elimination of flake-sensitivity in square samples of 100 mm. on a side. An increase in the temperature up to 1050° C. speeds up the process, but any further increase gives no substantial acceleration. Extended annealing at 1160°-1180° C. reduces the flake-sensitivity, but complete elimination requires a long time. The disappearance of flake-sensitivity during annealing is not due to the homogenization of H_2 in the solid solution but to its evolution from the steel. Optimum conditions for diffusion treatment are in many cases not yet definite. BZK (5a)

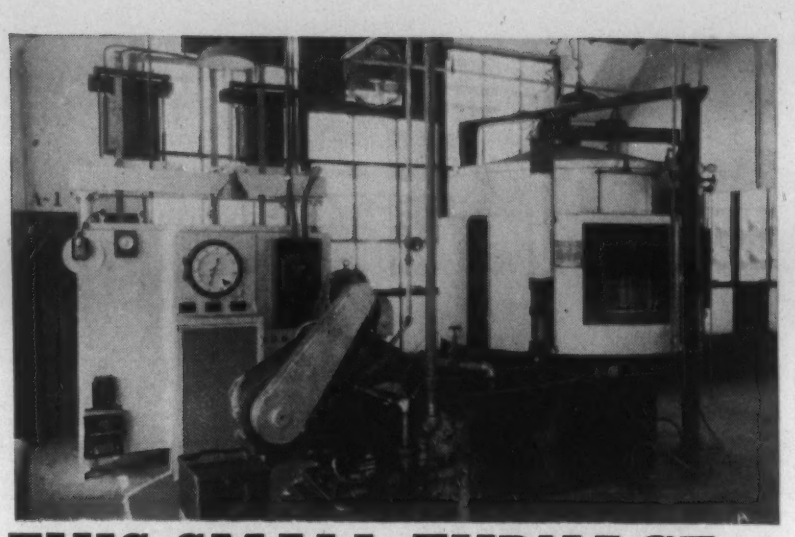
Hardening "Moly" Steels. *Steel,* Vol. 103, Oct. 3, 1938, pp. 48-49. Descriptive. Mo steels with 0.40-0.50% C are particularly adapted to flame hardening, as close temperature control is not imperative in this case and, next to C, Mo is the most effective hardening agent normally added to steel. Regardless of the type of steel, C range should be 0.35-0.50%, preferably 0.40-0.45%. Steels should be fine grained. Physical properties desired in the core of the finished part determine preliminary heat treatment. It is recommended, however, that steel be at least normalized. Flame hardening has no effect on core properties developed by preliminary heat treatment, and produces no distortion in Mo steel parts after hardening. Cr-Mo steels, SAE 4140 and 4150 are prominent among those suitable for flame hardening. These harden in excess of 80 scleroscope or 600 Brinell, for case depths up to 5/16 in. Hardened parts show uniform case depth. Hardness decreases gradually, instead of abruptly. Between case and core, there is a zone where structure changes gradually. This acts as a bond and tends to reduce spalling of case under load. Mn-Mo steel containing 0.40-0.45% C, 1-1.20% Mn and 0.20-0.30% Mo gives excellent results. Steel with 0.45-0.55% C, 1-1.25% Mn, 0.40-0.60% Cr, 0.06-0.10% S and 0.10-0.20% Mo has been flame hardened. Pins made of 0.50% C steel of this type, heat treated to 150,000-170,000 lbs./in.^{2} tensile strength, were hardened to produce a 1/16 in. case with hardness of 700 Brinell. MS (5a)

Temper-brittleness in Alloy Steels. J. A. Jones. *Metal Treatment,* Vol. 4, Autumn 1938, pp. 97-101. Original research. Steels that show no signs of temper-brittleness after slow cooling at the rates usually employed (1/3° C./min.) may still exhibit brittleness on prolonged service at 350°-500° C. Determinations of the notched bar impact strength of 8 steels after heating for periods up to 3000 hrs. at 350°, 400° and 450° C. indicate that appreciable embrittlement occurs in 3% Ni-Cr, 3½% Ni and 3% Ni steels, particularly at the higher temperatures. The addition of 0.32% Mo to a Mn-Mo steel with 1.55% Mn heat-treated to 62 tons/in.^{2} is not sufficient to stop long-time embrittlement, but a steel with 0.21% Mo and 1.42% Mn heat-treated to 47 tons/in.^{2} shows much less embrittlement. A new steel (Durehete) containing 1% Cr, 0.57% Mo, 0.65% Mn and 0.5% C is not affected after 20,000 hrs. at 415° C. The observations of Houdremont & Schrader (*Metals and Alloys,* Vol. 5, Apr. 1934, p. MA 133) that repeated slow coolings from 650° C. will restore the impact values have been confirmed. This improvement, however, is accompanied by a drop in hardness. By repeated slow coolings from 600° C., a similar recovery in impact strength can be secured, with less softening. JCC (5a)

Spring Washers. *Steel,* Vol. 103, Oct. 17, 1938, pp. 58-59. Describes heat-treating practice of Philadelphia Steel & Wire Corp., Philadelphia, Pa. Fine-grained spring steel, with 0.60-0.70% C, in hot-rolled rounds and shapes is used. It is cold drawn to the various sizes required. Some of the smaller sections require 8-10 passes through wire-drawing plates. Wire is given a spheroidizing treatment at about 1300° F. between each pass. Washers are fabricated on specially designed machines that coil and automatically sever each convolution. Hardening is done in automatically controlled closely muffled rotary-retort type gas-fired furnaces. At the discharge end, work passes through an oil-sealed chute into a rotary quench drum without coming into contact with atmosphere, thus holding decarburization and scaling to a minimum. After fracture and hardness tests are made, washers are washed to remove quenching oil, and drawn at 500°-700° F. in an automatically controlled electric dense-load forced-convection air-tempering furnace. Hardness of 48-53 Rockwell C is produced. MS (5a)

Precipitation-hardening in Three Steels Containing Vanadium. H. H. Burton & T. F. Russell (English Steel Corp.) *Iron Steel Inst.,* Advance Copy No. 4, Oct. 1938, 18 pp. Original research. One steel contained 0.26% C, 0.58% Mo and 0.30% V; another, 0.20% C, 0.60% Mo and 0.30% V; while the third contained 0.25% C, 0.66% Cr, 0.56% Mo and 0.30% V. All were susceptible to temper-hardening processes when tempered in the range 500-625° C. The degree of hardening depended on both the time and temperature of tempering. Temper hardening was accompanied by a marked drop in notched-bar impact resistance, but toughness was recovered when softening set in, due to coalescence. From a detailed study of the tensile strengths, impact values, dilation, relative densities and carbide analyses on one steel, it was concluded that the temper hardening was due to precipitation of V_4C_3 from supersaturated solution in α Fe, as suggested by Houdremont, Bennek and Schrader. Precipitation of Fe_3C may be somewhat of a factor in the hardening. JLG (5a)

Practical Pointers on the Heat Treatment of Tools. R. B. Seger (Lindberg Steel Treating Co.) *Modern Mach. Shop,* Vol. 11, Oct. 1938, pp. 54-60. Practical suggestions are given on proper treatment of tools, according to their composition to avoid warpage and size change. Slow and uniform heating, uniform quenching, quenching solutions and air quenching are discussed, and surface changes explained. Ha (5a)



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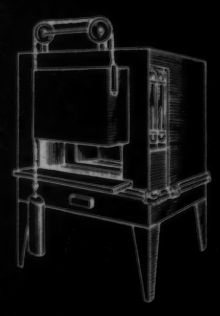

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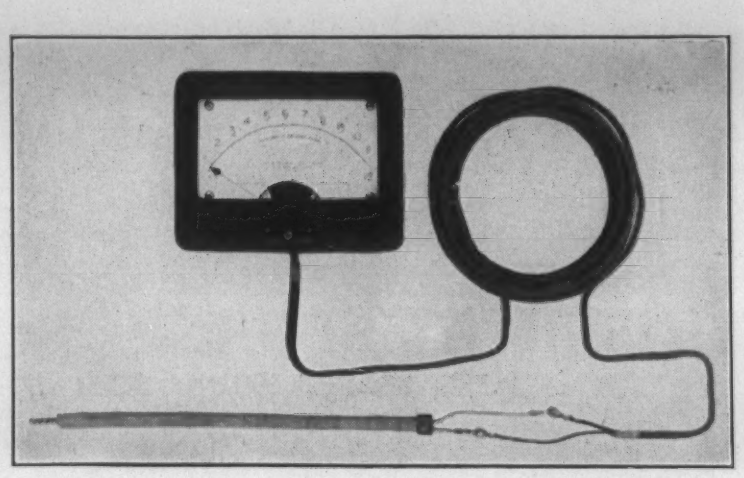

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The Heat Treatment of Steels in Neutral Atmospheres (Sur les Traitements Thermiques des Aciers en Atmosphères Neutres) E. HERZOG. *Métaux & Corrosion,* Vol. 13, Sept. 1938, pp. 153-163. Review. The Fe-O_2 reaction is discussed. The O content in a reducing atmosphere (CO, H_2) should not be more than 0.4%. About 0.2% Ni or Cu somewhat reduces the oxidation of the steel. Review of the Fe-H_2/H_2O and Fe-CO/CO_2 reactions shows that the oxidation of Fe is prevented when the H_2/H_2O ratio is 0.8/0.20 between 600° and 1100° C., or when the CO/CO_2 ratio is 0.75/0.25 between 500° and 1100° C. Sulphur dioxide is also an important factor in steel-gas reactions. In presence of Ni in steel, the SO_2 from the fuel causes a deterioration along the grain boundaries with the formation of S and Ni oxide. Protective atmospheres in current use are discussed; these are N_2, H_2, H_2-N_2 mixture, H_2-CO mixture, hydrocarbons, etc. 22 references. GTM (5a)

Tempering Martensite (Studio sul rinvenimento della martensite) V. MONTORO & V. ROSSI. *Met. Ital.,* Vol. 30, Sept. 1938, pp. 495-498. Original research. Systematic determinations of the temperature coefficient of electrical resistance in relation to the hardening and tempering of a "eutectoid" steel (0.75% C, 0.24% Mn, 0.18% Si, 0.014% S and 0.011% P) were made. The resistance was determined at 20° C. and at 40° C., and the coefficient of resistivity α calculated using the formula $\alpha = \frac{1}{\rho_{20}} \frac{\Delta\rho}{\Delta t}$. The steel was first hardened from 790° C., then tempered at increasing temperatures. Below are listed values for $\alpha \times 10^4$:

Tempered at °C.	$\alpha \times 10^4$
40	18.2
100	18.3
150	21.0
200	25.5
300	27.5
400	29.8
680	31.2

Thus, the value of α is an index of the temperature at which the steel was tempered. AWC (5a)

Quantity Production. WALTER G. BAIN (Allis-Chalmers Mfg. Co.) *Steel,* Vol. 103, Sept. 5, 1938, pp. 56, 58. Describes automatically controlled and conveyorized carburizing, hardening and drawing furnaces of continuous type installed in tractor works of the author's firm at Springfield, Ill. These have increased the amount of work handled and lowered costs per unit. Old pack hardening equipment has been replaced by continuous gas carburizing units (overall length, 55 ft. each) that operate on a 15-hr. cycle and produce 450 net lbs. work/hr. of carburized track pins, bushings and shafts of S.A.E. X-1020 steel. Carburized parts are hardened in continuous belt-type furnaces. Track links of S.A.E. 1045 steel are hardened differentially by heating in rotary hearth furnaces, discharging manually and placing in timed quenching jigs. Track shoes and axle shafts are hardened in large 3-zone furnaces with continuous chain-belt hearths, time-quenched in water and tempered at 300°-500° F. in recirculating hot air furnaces. Forged drive sprockets are quenched in a new centrifugal quenching machine, which hot-forms the piece and automatically times the quench to harden only the teeth. MS (5a)

Grain Size and Hardenability in Steels to Be Heat-treated. EDGAR C. BAIN (U. S. Steel Corp.) *Iron Steel Inst.,* Advance Copy No. 2, Oct. 1938, 24 pp. Up-to-date review. Numerical data show quantitatively the degree to which increasing grain size in a hardenable steel of given composition increases the hardenability and, similarly, indicates the degree of the superiority with respect to toughness or impact strength of the heat-treated steel of fine austenitic grain size. An explanation of grain-size effects is offered and supported, which postulates that the hardenability is a matter of the rate of nucleation and that the grain size is both one of the means of controlling nucleus formation and, at times a reflection of it. JLG (5a)

Carburization of Steel by a Gaseous Carburizer (Das Aufkohlen von Stahl durch ein gasförmiges Kohlungsmittel) *Tech. Blätter,* Vol. 28, Sept. 18, 1938, pp. 560-561. Descriptive. A new gas carburizing method employs 3 different stages of treatment. Within the first temperature range, 650°-815° C., the hydrocarbon carburizing medium is decomposed, partly catalytically by the work. In the second temperature range, 840°-980° C. the carbon deposited is oxidized to CO, which is the actual carburizing medium. Finally, a subsequent diffusion takes place at the same temperature. The carburizing gas is composed of a hydrocarbon, an oxidizing medium, essentially CO_2, and a diluting agent, *e.g.* dried flue gas with 8-15% CO_2. GN (5a)

Heat Treatment for Die Blocks. T. A. LEDIN (A. Finkl & Sons Co.) *Iron Age,* Vol. 142, Aug. 25, 1938, pp. 41-43. Practical description of furnaces for heating die blocks. They are of semi-muffle, gas-fired box type, controlled automatically. After heat treatment, blocks are water-quenched and tempered. Furnaces are vertical pit type having separate combustion chamber behind heating chamber. Temperature may be controlled within 5° F. VSP (5a)

Flame Hardening and its Principles. H. H. LANGEBECK. *Welding J., N. Y.*, Vol. 17, Sept. 1938, pp. 28-32. Research reported for effect of Mn on hardness obtained in flame hardening, using low and high pressure air and water for quenching. With a Mn spread from 2.2 to 2.9% (C, 0.22 to 0.33%) hardness rises from 380 to 580 Brinell for water quench. Surface cracking does not occur with Mn up to 2.9% if the steel has been properly annealed before hardening and if the hardening operation is well controlled. Two methods of flame hardening, (1) progressive and (2) spinning are discussed as to hardening conditions, hardness penetration and transition zone. In (1), where the quench follows the torch, the flame size, distance from treated surface and speed of travel control hardness and penetration. In (2), where the steel is spun, heated with the torch and quenched by immersion, the above factors apply, together with the number of revolutions during treatment. The latter discussion is in the nature of a review of the literature with curves to show relationship between temperature attained, hardness and penetration. The softer transition zone below the hardened zone is considered of benefit in preventing spalling of hardened surface, due to its ductility.
WB (5a)

Some Factors Influencing the Durability of Chrome-magnesite Bricks in Basic Open-hearth Steel Making Furnaces. W. HUGILL & A. T. GREEN. *Trans. Ceram. Soc.*, Vol. 37, July 1938, pp. 279-288. Original research. The deterioration and crumbling of chrome-magnesite bricks taken from a basic open-hearth furnace that had been subjected to very severe conditions after 190 heats are assumed to be due to the following mechanism: (1) Fe oxide is absorbed by the hot face of the bricks. In this zone the grains of chromite grow by taking magnetite into solid solution. The matrix, which is relatively rich in magnesia, is largely converted into a less refractory mixture of magnesia, ferrite and meta-silicates. (2) The strains set up by the growth of the chromite grains induce: (a) A crumbling disintegration of the working face; (b) a movement of the mobile matrix within the brick until it reaches a zone where the temperature is such that it can solidify; (c) the formation of a layer about ½-1 in. thick by this process. (3) When the hot face has been worn back further by disintegration, the temperature rises at the second zone, liquefaction again takes place, with the result that a more serious breakdown of the surface occurs. GTM (5a)

Lathe Beds Are Flame Hardened in One Pass. *Steel*, Vol. 103, Oct. 10, 1938, p. 96. Descriptive. Beds are alloy steel castings having a hardness of 225-240 Brinell. After finish-planing, ways are clamped in a water tank with just the surface extending out of the water. Oxyacetylene torches with multiple tips fastened in a carriage traverse length of ways at 3-6 in./min., depending upon thickness of the bed section being hardened. Tips are the quenching type. Depth of penetration of hardened metal varies from ⅛ to ¼ in. or more. Strains are prevented by keeping bed at room temperature during hardening. Repeated tests show no tendency for hardened portions to crack or flake, even under abuse. Hardened way surfaces have a hardness of about 590 Brinell. Distortion varies from 0.005-0.015 in. over length of entire bed and is corrected in subsequent grinding. Exact procedure details are determined by tests on way sections about 13 in. long.
MS (5a)

The Action of Hydrogen on the Carbides of Iron and Chromium. *Metallurgist (Suppl. Engineer)*, Aug. 1938, pp. 156-157. Extended abstract of the work of L. Jacqué in *Compt. Rend.* See *Metals and Alloys*, Vol. 9, Dec. 1938, p. MA 711 L/6.
VVK (5a)

5b. Non-Ferrous

M. E. MAWHINNEY, SECTION EDITOR

Bright Annealing Wire. J. B. NEALEY. *Steel*, Vol. 103, Oct. 31, 1938, pp. 50-51. Describes practice of F. A. Harris, Inc., Springfield, Mass., in manufacturing fine wires of brass, bronze, Ni, Ag, Monel and other non-ferrous metals and alloys. Wire is drawn down from ⅛-in. round stock in continuous machines containing 10-22 drafts or dies each. Tungsten carbide dies are used in reducing large wire, and diamond dies small wire. Each reduction is usually followed by an anneal. Frequency of anneal varies with type of wire. Strands are annealed individually in a continuous furnace, 18 ft. long with heating chamber 25 in. wide and 14 in. high, holding up to 120 lengths of ordinary Fe pipe, through each of which a single strand passes. Pipes containing prepared atmosphere, introduced through manifolds of block castings about 3 ft. from discharge end of tubes, to assure bright finish. Various atmospheres, such as CO_2, N_2, H_2 and city gas, are used, depending upon product. Furnace temperatures range from 700°-1650° F., while wires are pulled through at 50-600 ft. per min. There are 26 gas burners on each side of the underfiring hearth, and 3 separately controllable temperature zones. MS (5b)

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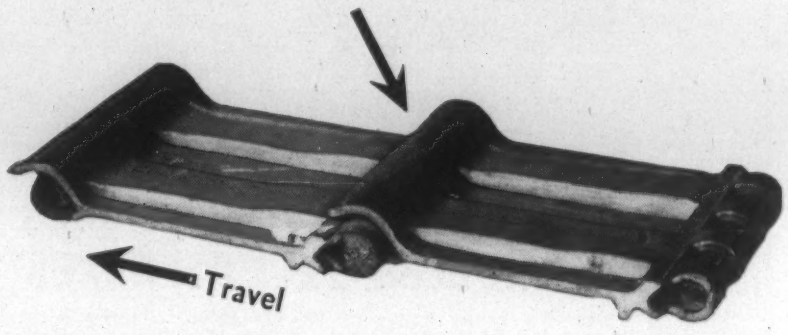
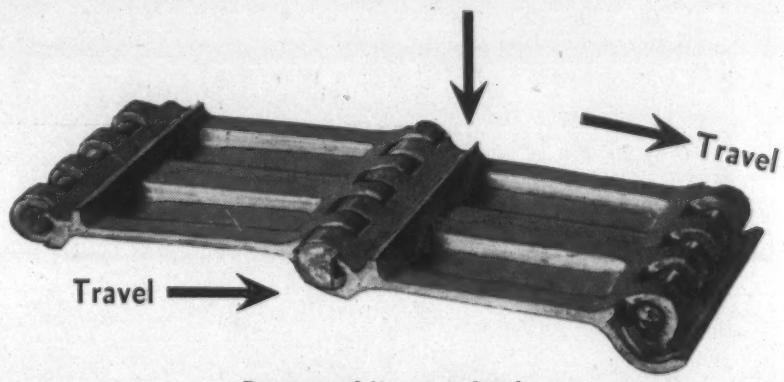


Top View—4 links—1/64th side clearance. Note shroud covers "piano hinge." Driving tooth here



Bottom View 4 Links

RELIABILITY—from straight across driving tooth. No stoppages from teeth failing to mesh in pockets and "riding up." No jamming of hinges with sharp edges of stock.

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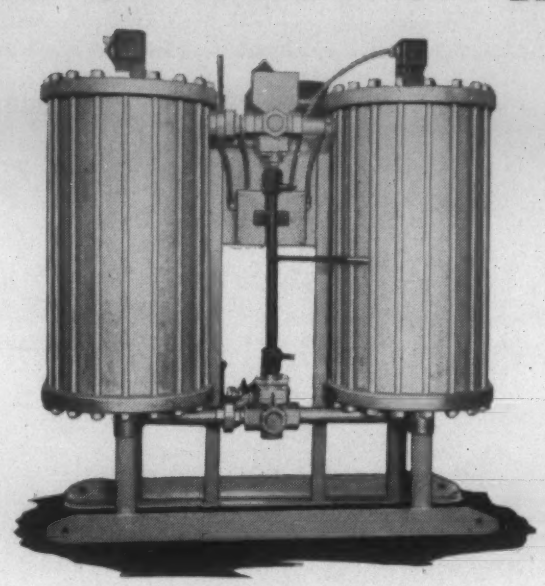

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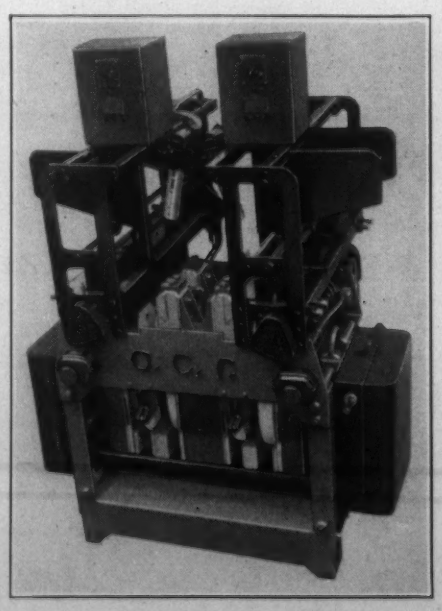

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Some Characteristics of Copper-aluminum Alloys Made from Aluminum of Very High Purity. MARIE L. V. GAYLER. *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 807, 15 pp. Original research. It is very difficult to obtain a 4% Cu-Al alloy made from super-pure French Al in such a condition that it will age harden uniformly to the maximum extent at room temperature. Hot working followed by solution heat treatment at 500° C. results in little or no hardening at room temperature. The microscopic examination of such material shows segregated areas of fine particles of $CuAl_2$, which alone would be sufficient to account for non-uniform results. The lack of homogeneity in the age hardening is due to the fact that the alloy is not easily work hardened, owing to the Al matrix being plastically deformed without appreciable work hardening, probably because of self-annealing during working, and also because particles of $CuAl_2$ act in a manner similar to that of the hard particles in a bearing alloy and are, therefore, little deformed except under special conditions. A brief examination was made of the effect of added impurities on the grain growth of recrystallized Al. The fine grain size of the 4% Cu alloy containing Fe is due to the mechanical prevention of grain growth by the presence of the insoluble Fe-rich constituent in the grain boundaries. JLG (5b)

Development of Abnormally Large Grain Sizes in Rolled and Annealed Copper Sheet. MAURICE COOK & C. MACQUARIE. *Metals Tech.,* Vol. 5, Sept. 1938, T.P. 974, 16 pp. Original research. Abnormally large crystal sizes can be developed in rolled Cu strip or sheet provided the final cold rolling reduction exceeds about 95% and the final annealing temperature is of the order of 1000° C. Also, large crystals can be produced under the same conditions of final annealing, with a cold reduction of not less than 85%, provided the temperature of the penultimate anneal does not exceed 550° C., and that the total cold rolling exceeds 96%. The structure after these heavy reductions is similar whether the final rolling is the same or normal to the direction of previous rolling. If the final reduction is limited to 30-70%, and is effected normal to the direction of previous rolling, the largest crystal size crystals in this case are smaller, more equiaxed, and free from is obtained by annealing finally at about 800-850° C. The circular markings and structures. These results were obtained with 2 brands of high-conductivity Cu, but with P-deoxidized Cu and less pure Cu, such as tough pitch and As-Cu, large crystals were not produced by any sequence of operation. JLG (5b)

Some Furnaces for Aluminum Alloys. *Aluminum & Non-Ferrous Rev.,* Vol. 3, Aug. 1938, pp. 304-307. Descriptive. Electric furnaces are described for melting, billet heating and heat treating of Al alloys. For melting, a pot type furnace with hairpin heating elements is recommended. For billet heating, either batch-type or continuous furnaces can be used, depending on work; they are equipped with forced air circulation. Charging and moving can be done by means of: Inclined hearth, roller hearth, conveyor or slide rails. Heat treatment of Al alloys is done mostly at temperatures around 500° C. for solution treatment and 150°-200° C. for age hardening, respectively. The use of salt bath is not recommended because of difficult handling, cost of bath and trouble in getting the pieces to the quenching container without appreciable loss of heat. Electric furnaces with forced air circulation are preferred. They are available as horizontal and vertical types. RPS (5b)

Salt Baths for Heat Treatment of Light Alloys. *Aluminum & Non-Ferrous Rev.,* Vol. 3, Sept. 1938, pp. 332-334. Descriptive. Until recently salt bath furnaces had the disadvantage of high maintenance cost, chiefly because of deterioration of the tank or pot containing the liquid salt. A temperature gradient of 200° C. through the sides of the pot was not unusual, setting up severe stresses on the pot material. Another disadvantage was the danger of explosion offered by the muddy sediment of aluminum oxide that forms in the bath and settles to the bottom. These disadvantages are overcome by the use of special immersion heaters mounted a few inches above the bottom of the bath. The heating elements can be replaced without disturbing the bath. A number of safety devices are used to protect the furnace against excess temperature, drop in temperature, salt leakage, etc. RPS (5b)

An X-ray Investigation of Al-Cu Alloy and Duralumin Aged at Room and Higher Temperatures. T. TAKEUTI. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Oct. 1938, pp. 514-518. In Japanese. Original research. By means of X-ray diffraction, hardness test and microscopic examination, the change in structure of quenched Al-Cu alloy (3.4% Cu) and duralumin during aging and tempering at room temperature and at temperatures ranging from 150° to 350° C., is studied. In the aging temperatures between 150° and 200° C., complete agreement is obtained between the maximum width of diffraction and maximum hardness, but there is no broadening of diffraction—inspite of marked variation in hardness immediately after quenching, after aging at room temperature and after heating for 1 hr. at 150° C. NS (5b)

Aging. MARIE L. V. GAYLER. *Metallurgist (Suppl. Engineer)* Oct. 1938, pp. 166-169. Part I of a very comprehensive review. Aging is considered under the following headings, the first 2 of which are covered in this issue: (1) Equilibrium diagrams of alloys that possess the property of age hardening; (2) characteristics associated with age hardening; (3) factors affecting age hardening; (4) theories of age hardening; (5) practical applications of this property in alloys; and (6) associated problems of age hardening that need further investigation. 36 references. VVK (5b)

Age-hardening of Duralumin. MORRIS COHEN (Mass. Inst. Tech.) *Metals Tech.*, Vol. 5, Oct. 1938, T.P. No. 978, 12 pp. Original research. Aging in quenched duralumin was followed at 30, 65, 100, 150 and 191° C. by hardness, microscopic, lattice, length and electric resistance changes. Results indicated that the basic aging mechanism involves a pre-precipitation stage as well as actual precipitation. The pre-precipitation change is a process of nucleus formation in preparation for the precipitation of $CuAl_2$. Localized precipitation sets in first along the grain boundaries, and this is followed by general precipitation within the grains. The pre-precipitation stage is indicated by a slight contraction and a considerable increase in electric resistance, but no change in microstructure or lattice parameter. The localized precipitation stage is characterized by a slight expansion, a modest decrease in electric resistance and a darkening of the grain boundaries, but still no change in lattice parameter. The general precipitation stage is accompanied by a large expansion, a rapid decrease in resistance, a darkening of the whole microstructure and a change in lattice parameter. These 3 stages may overlap to a considerable degree, but they proceed at different rates and are sufficiently distinct in duralumin to result in 3-step hardening. During the room-temperature aging of duralumin, the hardening is essentially due to nucleus formation. Any actual precipitation that may occur at room temperature is incidental and not a vital factor in the hardening mechanism. This combination of nucleus formation, localized precipitation and general precipitation offers a comprehensive picture of the age-hardening process. JLG (5b)

X-ray Studies of the Age Hardening of Super-duralumin. G. SHINODA. *Nippon Kinzoku Gakkai-Si*, Vol. 2, Sept. 1938, pp. 475-481. In Japanese. Original research. The aging of super-duralumin (RF 1:4.01 Cu, 1.77% Mg; RF 2:4.09 Cu, 1.12% Mg) and Al-Cu alloys (2% and 4% Cu) was investigated by the X-ray back reflection focussing method using Cu K_α radiation. The quenched specimen was fixed on an X-ray camera and the incident X-ray beam was adjusted so as to illuminate the same part of the specimen always from the same direction. Photographs were taken immediately after quenching, after 15 min., 30 min., 1 hr., etc. Some of the spots reflected from (511) planes of super-duralumin change their shapes by internal strain or by bending of crystal grains during aging; this continues for several hours. At first, the change in the position of the spot is random but finally it displaces to the side of larger lattice constant. The mean dilatation of the lattice after 20 hrs. was 0.0121% and 0.0274% for RF 1 and RF 2, respectively, while the lattice constants immediately after quenching were 4.036 and 4.035 A.U., respectively. The change in the shape of the spot and the displacement of its position is not remarkable in Al-Cu alloy, but in 4% Cu alloy, bending of the atomic plane during aging was very noticeable. The tendency of lattice dilatation in Al-Cu alloys was also observed. NS (5b)

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6 · WELDING AND CUTTING

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

Impact Tests of Welded Joints. Part II. Review of the Literature from Jan. 1, 1936 to Jan. 1, 1938. W. SPRARAGEN & G. E. CLAUSSEN. *Welding J., N. Y.,* Vol. 17, Sept. 1938. Suppl. pp. 8-27. A 4-page summary condenses the details of the extensive review which covers tensile impact, fillet weld impact, notch and repeated impact. Results of notch impact tests for various steels and regions of welded joint and different welding methods are covered in greatest detail. The literature gives proof of the good impact properties in the heat-affected area of the welding steels, and many cases are cited where higher values than for base metal are obtained. Acceptance specifications for welded structures are in the direction of requiring minimum impact values for welded joints. The effects of C and alloy, O_2 and N_2 on impact are reviewed. For the low alloy steels with low C, the higher impact values of heat affected area than for base metal are particularly noteworthy. The effect of annealing, weld procedure and properties at low and elevated temperatures are detailed. The data are presented as tabulated values and curves. Type and position of impact specimens are illustrated. 175 references. WB (6)

6a. Ferrous

An Analysis of Heat Effect in Welding. W. G. THEISINGER *Railway Mech. Eng.,* Vol. 112, May 1938, pp. 176-181. Research. The effect of welding speed on the hardness of the weld, the heat affected zone and the plate were investigated in plain C and low-alloy steels. The principal harmful effect is the hardening in the metal adjacent to the weld, which sometimes results in cracks in the parent steel. The hardness increases noticeably with increasing welding speed; in a 0.17% C steel the Brinell hardness was 125 up to 6 in./min., increasing sharply to 160 at 8 in. and then more gradually to 220 at 18 in./min. The factors that govern the heat-affected zone are the base-metal composition, welding speed, heat energy applied and base-metal cross-section; the hardness increases with increasing C content. The hardening effect is more pronounced in low alloy steels. A low C content is helpful as it decreases the hardness materially at any welding speed. Sets of curves show this effect clearly for Ni, Cr and Mo steels. C-Mo steels can, however, be very easily welded; Mo substantially aids the weldability of steel and keeps the hardening effect in the affected zone adjacent to a weld extremely low. Ha (6a)

Welding Silicon Steels—A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN. *Welding J., N. Y.,* Vol. 17, Sept. 1938, Suppl. pp. 1-7. The review includes a summary, introductory discussion from the data on physical properties, recovery and pick up of Si in welding, fusion welding properties, resistance welding, forge welding, flame cutting. There appears to be no difficulty in obtaining high strength welds in 1-2% Si steels, but with only fair ductility. The recovery of Si in the weld is dependent on the C content and range of Si of the rod, recovery increasing with C and Si content. Difficulties in welding Si steels (more than 1% Si) and "silicon structural steels" (less than .45 Si and 1.0 Mn), due to cracking and poor fusion, are detailed, showing some inconsistencies in the literature. 66 references and 5 suggested research problems are appended. WB (6a)

Application of Arc Welding in Ship-building (Die Anwendung der Lichtbogenschweissung im Schiffbau) FRANZ CLAASEN. *Werft, Reederei & Hafen,* Vol. 19, Sept. 15, 1938, pp. 273-275. Up-to-date review. The occurrence of cracks in the welds or their vicinity during assembly are frequently due to a local accumulation of too many welds and subsequent heat stresses. The application of strengthening plates is not recommended as a remedial measure since new heat stresses are introduced. Plain welding rods and cored rods *(Seelenelektroden),* but not coated ones, are used for structural steels St 42 and St 52. As to welded tankers, the difficulties due to corrosion attack of gasoline on welds have not yet been completely solved. EF (6a)

Thermal Disturbance During Welding—Considered in Relation to the Hardness of Arc Fillet Weld Areas in Steel. Part II. T. B. WILKINSON. *Trans. Inst. Welding, London,* Vol. 1, Oct. 1938, pp. 227-234. Original research. Establishes the relation of the Bain S-curve to the transformations occurring in the overheated parent metal adjacent to the weld bead. The author devotes considerable discussion to a review of the data on experimentally determined cooling rates (given in tables and curves) for fillet welds in the Reeve type of weld cracking test, as related to heat impact and position of thermocouples in both legs of the fillet. The practical assessment of approximate cooling rate by observation of temper colors was established by comparison with thermal cycles previously determined and by comparison of maximum Vickers hardness values obtained in the heat affected area. The effect of chemical composition and heat input (increasing current) on the maximum Vickers hardness and decomposition products in the microstructure is discussed and data given in tables and curves. Consideration of the Bain S-curve characteristics for a certain chemical composition of steel is brought into the discussion by implying that the high quenching temperature, the resulting grain growth next to the weld bead and the alloy or C contents result in considerable austenite stability for the overheated parent metal. The transformation of austenite may take a long time under these conditions and the possibility of obtaining soft, high temperature transformation products exclusively; hard, brittle, low temperature transformation products or mixtures of the 2 products, depending upon heat input during welding, preheat and chemical composition of the steel, are indicated by the author by superimposing the thermal cycles of the heat affected zone on the Bain S-curve. Some quench tests were made on a series of steels by heating small specimens to 925° C. and quenching in a PB bath at 500° C. for 10, 20 and 40 seconds. Other quench tests were made by heating larger specimens with arc deposited weld metal and quenching in the same way. The conclusion from these tests was that the metallographic structures could be reasonably correlated with the heat treatment undergone and that the 20-sec. stay in the quenching bath was critical for assessing the relative rates of austenite transformation for the various steels. Some tests are reported for welding carried out at 200° C. preheat with different sizes of weld, and maximum Vickers hardness reported. The results indicate that a large weld made at room temperature may result in less hardening than a smaller weld with 200° C. preheat; therefore, it is desirable to indicate the size of the weld when statements are made respecting the decreased hardness resulting from preheat. Preheating to 200° C. is considered to ensure freedom from weld cracking since the austenite may transform to martensite over a long period of time at this temperature. For Part I, see *Metals and Alloys,* Vol. 9, Nov. 1938, p. MA 654L/7. WB (6a)

Welding of Steel St 52 in Shipbuilding (Ueber das Schweissen von St. 52 im Schiffbau) RAPATZ. *Werft, Reederei & Hafen,* Vol. 19, May 15, 1938, pp. 136-138. Original research. Increasing the tensile strength from 53,000 lbs./in.^{2} (Steel "St 37") to 74,000 lbs./in.^{2} (Steel "St 52") by applying more alloy additions rather than higher C content, introduced new problems and difficulties in welding. The following maxima in St 52 cannot be exceeded: 0.2% C, 0.5% Si, 1.2% Mn, 0.55% Cu, 0.4% Cr and 0.2% Mo. Cracks occurring in weld and parent metal of structural steel St 52 are due to excessive hardening of parent metal or weld to, say, 400 Brinell instead of 200-250 Brinell, or are due to defective welds. This may be offset by careful selection of St 52 grades of steel that may differ considerably in chemical composition, and by using larger electrodes for heavy sheets. By specifying "deformable welds," the safety of the weld is by no means assured, particularly in vertical and overhead welding so much employed in ship-building. Unreasonable demands as to ductility, impact strength and bending angle are unnecessarily severe restrictions that insure against neither higher static nor dynamic loads. A critical comparison between coated and cored electrodes *(Seelenelektrode)* is made. The latter have gained a predominant position in German ship-yards. EF (6a)

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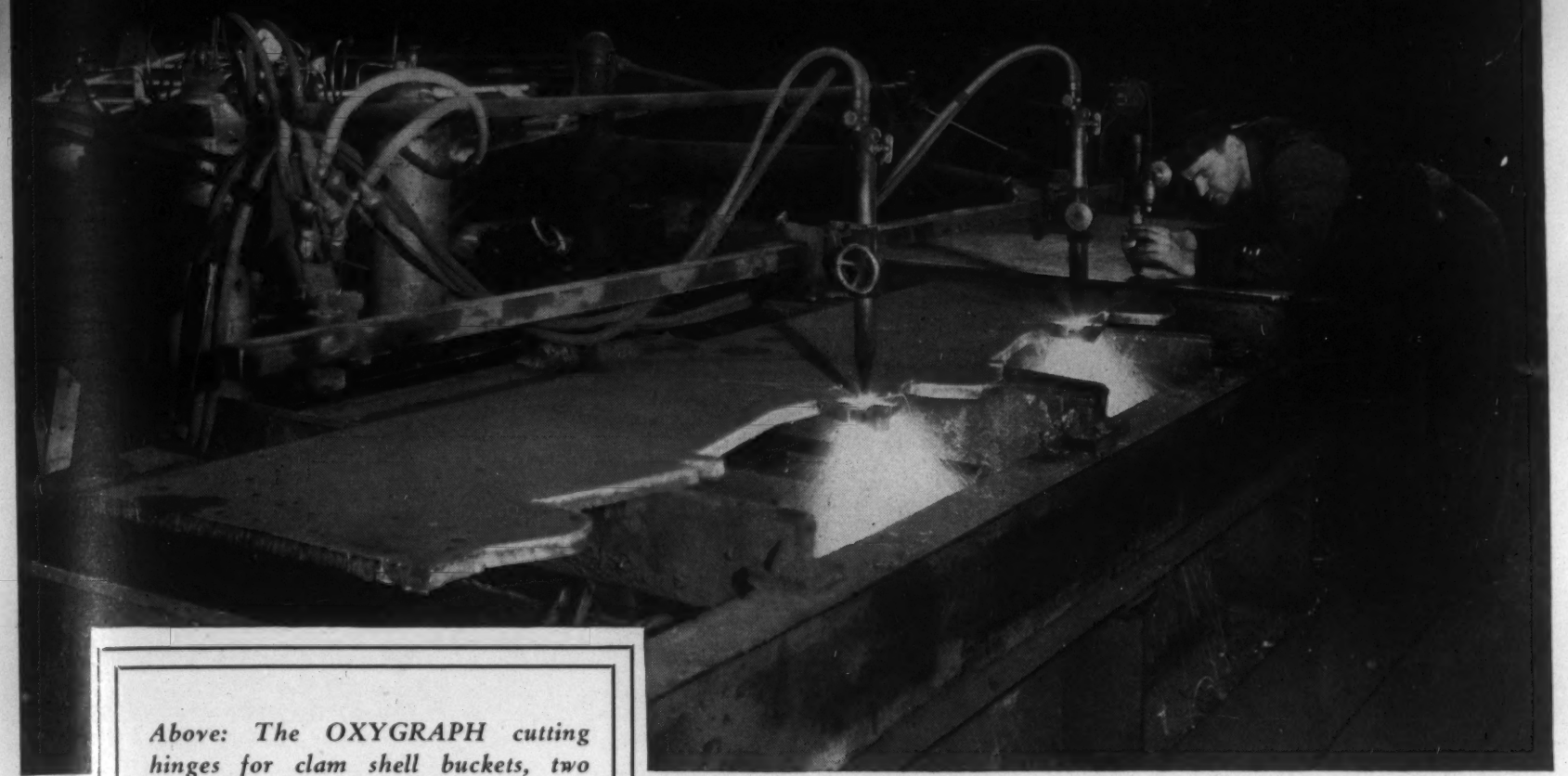

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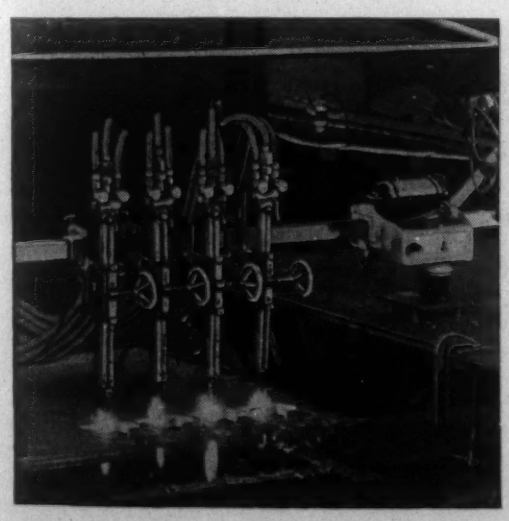

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Tests of Welds in Alloy Steels. S. F. YASINES & F. C. FAIR (N. Y. Univ.) *Welding J., N. Y.,* Vol. 17, Sept. 1938, Suppl. pp. 28-33. Research to determine (1) relative hardness and impact strength of weld, heat-affected zones and base metal; (2) existence of relation between hardness and impact of various critical sections; (3) effect of heat treatment on weld and heat affected zones; (4) relative merit of 2 kinds of electrodes. Four different grades of steel were welded and tested in "as-welded" and stress-relieved condition for impact of parent metal, weld root, and inner and outer zone of heat affected area. No definite relation exists between hardness and impact resistance since some of the weld and inner and outer zones showed impact resistance following hardness trend, while other tests showed an inverse relation. Stress relief treatment gave slight improvement of impact strength of welds and heat-affected zone. WB (6a)

Field Practice in Welding Oil Well Casing. HOWARD L. NEWBY. *Welding J., N. Y.,* Vol. 17, Sept. 1938, pp. 17, 19. Review of requirements of casing pipe in tensile, compressive and impact strength, and description of method of producing the welded joint. Butt joint is produced with full penetration, no more than 1/32 in. internal bead and no more than 1/8 in. crown. Use of clamp for bringing ends of pipe together permits making accurate welds at a rapid rate. WB (6a)

Light Weight Passenger Coach Frame—Welding Design and Procedure Used in Construction. A. E. KATZ. *Can. Metals Met. Inds.,* Vol. 1, Nov. 1938, pp. 295-298. Descriptive. The changes in design and construction are dealt with sectionally as follows: Choice of machine, electrodes and operations, underframe layout and assembly, super-structure and sheathing, and final finishing. Welding operations include downhand-, butt and fillet-, plug- and butt-welding. WHB (6a)

6b. Non-Ferrous

Cold Welding of Silver. ALLISON BUTTS & G. R. VAN DUZEE (Lehigh Univ.) *Trans. Electrochem. Soc.,* Vol. 74, 1938, Preprint No. 32, 10 pp. Original research. 2 Ag surfaces in contact with each other were welded together at temperatures between 200° and 400° C. by application of a high pressure for a certain length of time. The welding is brought about by the interdiffusion of Ag atoms across the boundary. The surfaces were considered welded if the 2 strips could not be separated without tearing. The pressure required for welding was obtained in 2 ways: (1) By passing through rolls; and (2) by applying a static pressure. To secure a weld by method (1), the Ag strips heated to 400° C. were passed through rolls and received a 50% reduction in thickness. At lower temperatures, one pass through the rolls produced a slight adherence which could be converted into a good weld by further reduction in the rolls, no further heating being necessary. Method (2) consists in applying a pressure of 23,000-45,000 lbs./in.^{2} to Ag strips heated to 200-400° C. Welds were not obtained below 200° C. The welded specimens were only 20-25% as thick as the original strips. As the temperature of welding was increased from 200 to 400° C., the time necessary to produce a weld decreased from 16 hrs. to 0.5 hr. Also, at 400° C., the higher the pressure, the shorter was the time required to produce a weld. The bonding obtained by method (1) was better than that obtained by method (2). The Ag surfaces for welding by either method were prepared by the use of polishing paper. Films of metal oxides, charcoal, oil, grease, etc., did not materially lessen the adherence; graphite and talc slightly lessened the adherence. AB (6b)

Novel Welding Method for Thin Aluminum Sheets (Neues Verfahren zum Schweissen dünner Aluminiumbleche) E. HERRMANN. *Tech. Zentralblatt prakt. Metallbearbeit.,* Vol. 48, Oct. 1938, pp. 731-734. Original research. Describes Weibel's welding method in which 2 C electrodes are heated by means of a low-voltage a.c. The degreased edges of the Al sheets to be joined are edge-bent at right angles for 2-3 mm. and placed in juxtaposition. The backside is coated with a welding flux. The C electrodes are placed on the 2 sheets. Because of the short-circuiting, the tips of the electrodes become increasingly hotter until in 10-15 sec. the metal begins to liquefy. The welding speed is 500-600 mm./min. A 3 mm. diameter wire may be placed between the electrodes for a butt weld. For a sheet of 0.2-0.3 mm. thickness, a current of 50 amps. and 3-4 volts is used, while a 2 mm. sheet calls for 300-400 amps. and 7-8 volts. The heat is quite localized and no arcing occurs, owing to the low voltages used. A table shows the author's tensile tests on Al-Mg-Mn sheets welded according to the new method; the weld is finished in various ways and shows remarkable strength. Several microstructures of Al-alloys welded by the Weibel method and the distribution of hardness across a weld are shown. Welding of sheets of pure Al of 0.2-2.0 mm. thickness was successful and also tests with Al-Mn, Al-Mg-Mn, Al-Mg, Al-Mg-Si and Al-Cu-Mg. EF (6b)

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Protection of Magnesium against Corrosion (La Protection du Magnesium contre la Corrosion) J. FRASCH. *Métaux & Corrosion,* Vol. 13, May 1938, pp. 91-94; June 1938, pp. 115-120; July 1938, pp. 132-137. Practical. Mg becomes covered in air with Mg hydrate, which changes to the basic carbonate, which is porous and non-protective. Mg is more corrodible as it becomes purer. Cast Mg alloys are more corrodible than rolled alloys. Electrodeposited Cu on Mg is porous and does not protect against corrosion. As with Al, surface oxidation of Mg offers protection. Chemical oxidation is principally obtained by the action of solutions of chromates, titanates, manganates, molybdates, tungstates or vanadates. Mg (OH_2) is obtained by the simple action of steam under 5-10 lbs. pressure. Electrolytic oxidation with alkaline salt solution does not offer good protection. On using 2-10 volts in 5 to NaOH solution, the oxidation is violent and the oxide or hydrate film is porous and non-adherent. But by using for 10-40 sec. a current density of 0.4-0.6 amps./dm.^{2} with 10-20 volts in 1% NaOH, a strong and adherent film is obtained. Addition of Na_2SiO_3 to NaOH solution produces on Mg alloys a film that is less porous than that formed when only NaOH is used. Vitrification of this film insures corrosion resistance of Mg alloys. Such films are formed by using 40-50 volts at 15 amp./dm.^{2} and a bath of 1% NaOH and 5% Na_2SiO_3. GTM (7)

7a. Electrolytic Methods

Production of Electro-deposits on Aluminium and Its Alloys. *Light Metals,* Vol. 1, Oct. 1938, pp. 314-316; Nov. 1938, pp. 368-371. Review. The electrodeposition of metals on Al is a difficult and often uncertain process owing to the oxide film of Al_2O_3, always present on the surface of Al and its alloys. Jirotka developed a process which made use of the oxide film. In this method, an artificial film of Al_2O_3, was formed on the work in the presence of heavy metals that were simultaneously deposited. The Al_2O_3 coating probably aided in retaining the heavy metals on the plating surface by a mechanical inter-meshing or perhaps by being impregnated by the heavy metals. Considerable effort has been expended in the development of special electrolytes. One of the more successful plating baths is due to Govaerts, who worked with thiosulphates. The original bath has been considerably modified according to subsequent patents, but it is essentially a solution of heavy-metal thiosulphates in alkaline thiosulphate with an organic acid, often acetic acid, added until sulphur starts to precipitate. This bath has been suggested as suitable for deposition of Cu, Ag, Pb, Fe, Ni and Zn on Al or Al alloys. There is no information available as to the actual degree of success attending this method, but it is known that more or less satisfactory deposits are possible, especially on pure Al. Deposition on Al alloys has not been so successful, particularly if the alloy contains Si and Cu. The Aluminium Industrie A.G. has developed a molten electrolyte process for depositing Al on finished work in Al alloys where cladding is impossible. Deposition of the Al as flakes is prevented by co-deposition with another metal of a similar solution potential. Suitable metals for this purpose are Mn, Cd, Cr, Zn, Cu and especially Pb. The temperature of plating is, of course, below the m.p. of Al. The electrolyte contains a halide of Al with alkaline and alkaline earth halides. A suitable mixture consists of 75% $AlCl_3$, 15% NaCl and 10% KCl. An Al anode is used. The high temperature of the bath, 400-500° C., promotes a firm bond between the 2 surfaces. Ag may be plated on Al and Al alloys by first brushing a concentrated solution of $AgNO_3$ on the surface, and then heating the surface to decompose the salt to Ag. The anodized surface is not always necessary; immersion in a 3% NH_4Cl, 1% NH_4NO_3 solution will produce a film of oxide sufficiently thick for the purpose. The Elytal process of electroplating Al, which stipulates the formation of a partially porous oxide film on Al basis metal, was originally proposed for Cu-plating the contacting surfaces of Al bus bars. Such Cu-plated bars, when joined properly by screws or rivets, have a resistance at the joint of 25 x 10^{-6} ohm/cm.^{2}, while a similar joint in Al has a resistance of 500 x 10^{-6} ohm/cm.^{2} High current densities for short periods of time are used to give the proper type of oxidized surface for plating. The plating metal is supposedly held in place by a keying action of the irregular patches of the oxide film. In another process, the surface is first treated anodically, then cathodically, to obtain a layer of brass, and then cathodically again to produce the final desired coating. The intermediate layer, in this case brass, is plated on with a fairly high voltage, in order to break through the oxide film built up in the anodizing treatment. This treatment probably results in a surface condition somewhat similar to that described for the Elytal process. It is suggested that the anodizing bath contain the desired metal salts so that the same bath could be used cathodically for the preliminary plating, thus saving space and equipment. One type of pre-oxidation treatment uses chlorine-free sodium carbonate. Ag may be plated directly on Al by pickling the Al in a strongly acid solution of HCl, HF and HNO_3, and then in an alkaline bath of 10% NaOH saturated with NaCl. Ag may be plated to withstand repeated bending without peeling. The use of electro-plated architectural components is suggested, particularly Cr-plate. AUS (7a)

Anodic Behavior in Cyanide Copper Plating Baths. HAROLD J. READ (Univ. Penn.) & A. KENNETH GRAHAM. *Trans. Electrochem. Soc.,* Vol. 74, 1938, Preprint No. 1, 13 pp. Original research. The anodic polarizations of Cu and Fe anodes were measured in cyanide Cu baths of different compositions. In the plots of anode-polarization *vs.* current density, there were 2 points at which abrupt increases in polarization occurred for relatively small increases in current density. The first point occurred at a polarization voltage of 0.6 v. and a current density of 6-12 amp./ft.^{2}, and the second point occurred at a voltage of about 1.6 and a current density of 10-20 amp./ft.^{2} These points of inflection of the curves are considered to represent a change in the anode reaction from cuprous to cupric. An increase in concentration of free cyanide or of copper cyanide increased the critical current density at which the points of inflection occurred, but an increase in tartrate concentration decreased the critical current density. Hydrogen-ion concentration did not have much effect on the critical current density except in a bath containing 9 oz./gal. of Na_2CO_3. Increase of pH in this bath caused the Cu anode to behave as an insoluble anode, *i.e.* the critical points were absent, excessive polarization did not occur at high current densities, and the Cu anode did not dissolve. When a Cu anode and an Fe anode were connected together and placed in the bath, and the current density gradually increased, most of the current flowed through the Cu anode until the first critical point was reached, at which point some current also flowed through the Fe anode. The values of the polarization voltage and current density on the Cu anode at which the critical points occurred were not affected by the presence of the Fe anode. AB (7a)

Solvent Degreasing in the Plating Industry. H. R. NORGREN (Detroit Rex Prod. Co.) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 25, Oct. 1938, pp. 731-739. Descriptive. The vapor type degreaser does not remove insoluble matter from the surface. To accomplish this, the surface is sprayed with solvent at pressures of 25-30 lbs./in.^{2}, and in quantities of 80-120 gal./min. The solvent degreasers may be used in connection with automatic or semi-automatic plating systems. The solvent most commonly used is trichlorethylene, and it is stabilized against decomposition by proprietary substances. The average cost of cleaning by this method is $0.70 per ton of work. AB (7a)

Hard Chromium Plating (Die Hartverchromung) OSKAR KRÄMER. *Metallwaren-Ind. Galvano-Tech.,* Vol. 33, Oct. 1, 1938, pp. 411-422. Up-to-date comprehensive review. Among the 22 illustrations are diagrams showing the limiting temperatures and current densities for bright Cr plating and current yield in relation to current densities and bath temperature for 5 plating solutions. Macrostructures of various Cr deposits are shown. Numerous commercial applications of hard Cr plating are discussed. EF (7a)

Electroplating of Tin Plate. Tin as a Basis for Nickel and Chromium. A. W. HOTHERSALL & C. J. LEADBEATER. *Metal Ind., London,* Vol. 53, Nov. 4, 1938, pp. 447-451. Original research. Sn-plate, electroplated with Ni or Cr under industrial conditions, was sometimes sufficiently adherent to enable the material to be worked; the maximum adhesion obtainable is the resistance to rupture offered by the Sn film. Mild steel tensile test specimens were electrolytically Sn-plated, then plated with Ni or Cr. Tensile stress was applied at an approximate uniform loading rate of 0.03 tons/min.; the breaking stress was observed and the adhesion in tons/in.^{2} calculated. Numerous tests were made to determine relative merits of various methods of cleaning. For degreasing Sn-plate, it was found advantageous to apply some form of solvent (vapor degrease) followed by a cathodic treatment in sodium carbonate (50 g. Na_2CO_3/l., 50-60° C., 50 amp./ft.^{2} and 5-10 min.). Anodic treatments that produced a visible oxide film on the Sn surface appeared to promote better adhesion than when only cathodic cleaning was used. An anodic solution of either ammonium citrate or sodium carbonate gave good results (30 amp./ft.^{2}, 4 min. room temperature). Following the anodic treatment, 0.00004 in. Cu was applied from a cyanide solution and followed by Ni-plate. The adhesion increased with the thickness of the Sn-plate, probably because irregularities in Sn-plate thickness caused uneven stress concentrations during tensile tests. Cu-Ni deposits showed better adhesion to thick Sn coatings than Ni deposits. Adhesion was reduced by buffing the Sn (probably because of locally drastic thickness reductions), especially if the anodic treatment were omitted. This effect was more pronounced, the thinner the Sn coating. Tests on Ni over Sn showed that Ni had a definite tendency to produce flaking and cracking. To secure the highest possible adhesion of Ni deposits to Sn surfaces, it was desirable to prevent access of H to the Sn, which was accomplished by use of either a Cu undercoat or an anodic treatment prior to deposition, or a combination of the two. Substantial reduction in porosity was obtained with thin Ni coatings. Also, the Ni-plated Sn-plate showed less porosity than sheet steel coated with Ni of corresponding thickness. The results of tensile and reversed bend tests on Sn-plate after cathodic cleaning and coating with Cu-Ni-Cr deposits showed a negligible effect of plating on the mechanical properties of the Sn-plate base, and even this disappeared in about 1 hr. Ni-plate showed embrittlement after Cr-plating which appeared to be due to H, as it could be removed by heat treatment or prevented by coating the Ni with Cu (0.00002 in.), and was still apparent after removal of the Cr. Sn-plate with a Cu-Ni-Cr deposit, 0.0003 in. thick, retained satisfactory appearance on deformation except when bright Ni was used. When the thickness was increased to 0.001 in., cracking was obvious. The Sn coating becomes porous on deformation and the probability of coincidence of cracks in Ni and discontinuities in Sn is great. The protective value of Cr plated directly on Sn-plate was most damaged by bending over a diameter of 0.06 in. or less. The protective value of direct Cr 0.00003 in. thick after fabrication appears to be superior to that of Cu-Ni-Cr coats. Sn-plate coated with Cr only to a thickness of 0.00003 in. has been pressed into cup shapes without flaking or noticeable cracking. RWB (7a)

A New White Brass Plating Process. FLOYD OPLINGER. *Metal Ind., N. Y.,* Vol. 36, Nov. 1938, pp. 513-516. Descriptive. White alloy deposits containing Zn and Cu in approximately 3/1 ratio are readily produced by plating process. The coatings are smooth, fine-grained and semi-bright, and may be buffed to a high lustre resembling Cr plate. Buffed samples are resistant to tarnish and finger staining, and are easily cleaned. The following bath composition is used: Zinc cyanide 8-10 oz./gal., copper cyanide 1.85-2.4 oz./gal., sodium cyanide 11-13 oz./gal., caustic soda 8-10 oz./gal. and sodium sulfide 0.05-0.1 oz./gal. Operating and control features are discussed. Salt spray life of deposits is proportional to the thickness of the plate. CBJ (7a)

Plating Zinc Alloy Die Castings Commercially. Part III. E. A. ANDERSON (N. J. Zinc Co.) *Metal Cleaning Finishing,* Vol. 10, Oct. 1938, pp. 679-684. Review. In the plants visited, Ni plating solutions were purified by the customary procedure of precipitating the Zn by increasing the pH, and pitting was prevented by oxidizing agents. Practically all plating racks used were of Cu or brass insulated with rubber or lacquer. Electrical connection to the work was made by spring contact, rather than by gravity contact. Defective Ni coatings were removed in most cases by the usual H_2SO_4 anodic strip. For Part II, see *Metals and Alloys,* Vol. 9, Nov. 1938, p. MA 660 L/6. AB (7a)

Plating Aluminum for Appearance and for Wear Resistance. R. F. YATES. *Product Eng.,* Vol. 9, Dec. 1938, pp. 481-482. Practical note. A very firmly adhering coat of Ni on Al is obtained by first anodizing the latter in a bath of oxalic acid, then modifying this coat in a solution of a chemical [not named] so that the article can be plated in a bright Ni bath or in either hot or cold gray Ni baths. A Cr deposit may be put on the Ni when required. The process is applied especially to small articles (hinges, handles, etc.) that must later be soldered. Ha (7a)

Filtration of Electroplating Solutions with Celite Filter Aids. RICHARD J. AMBERG (Johns-Manville Sales Corp.) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 25, Oct. 1938, pp. 741-747. Descriptive. Celite filter aids, which are diatomaceous earths of different degrees of fineness, prevent slimes from clogging filters, by forming a porous cake, and thus increase the rate of filtration. The clarity of the filtrate can be controlled by the fineness of the Celite. The filter cloth is first covered by a precoat which is formed by passing a suspension of Celite through the pump, about 10 lbs. Celite/100 ft.^{2} of filter surface being required. For filtering a plating bath, about ¼ lb. of Celite/100 gal. is used. The filter aid is either suspended in the plating solution, or the slurry, contained in a separate tank, is injected into the intake side of the pump as it sucks in the plating bath. Centrifugal pumps are preferable since they give a steady flow free from pulsations. The filter aid does not erode the pumps. The cost of filtration at the rate of 40 gal./hr. is $0.30/day, and, at the rate of 8,000 gal./hr., is $3.00/day. AB (7a)

Black Chromium Coatings (Schwarzverchromung) R. LIEBETANZ. *Metallwaren-Ind. Galvano-Tech.,* Vol. 33, May 15, 1938, pp. 220-221. Original research. Standard Cr plating solutions (250 g. chromic acid, 1.25 g. H_2SO_4/1000 cc. H_2O) furnish even at high current densities of 200 amps./dm.^{2} only dark-gray deposits. A great number of plating baths (compositions are given) were tried out at various temperatures and current densities. The best operating conditions for obtaining a black, adherent Cr coating of 75% Cr and 25% chromium oxide were found to be: 250-400 g. chromic acid, 5 cc. glacial acetic acid/1000 cc. H_2O, at 80-100 amps./dm.^{2} at the cathode, and 25° C. bath temperature. EF (7a)

7b. Non-Electrolytic Methods

The Application of Polishing and Buffing Wheels. Part IV. ROBERT T. KENT. *Metal Cleaning Finishing,* Vol. 10, Oct. 1938, pp. 694-704. Descriptive. The type of cotton cloth used in the construction of buffs is important. Cloth containing 64 x 68 threads per in. gives a soft wheel suitable for coloring operations, and cloth of the 84 x 92 construction gives a hard buff suitable for cutting-down operations. The yarn used for the cloth should be made of long fibers and spun with a tight twist. 4 types of buff construction are used: (1) Full disc buffs consist of about 20 discs of cloth sewed together in a section. They have good balance, give a high grade finish and have a long life. (2) Sewed piece buffs consist of small pieces of cloth interleaved in layers and sewed together. Since they may be made of waste from the manufacture of full disc buffs they are cheaper but usually do not have the balance or wearing qualities of full disc buffs. (3) Folded buffs consist of folded pieces of cloth overlapped and sewed together. (4) Continuous strip buffs are made by winding a strip of cloth into a circle. Types 3 and 4 are well ventilated and can be used under severe conditions that would char other buffs, and the wavy or puckered edges of the buff prevent the appearance of buffing marks. The method of sewing a buff can affect its performance. In general, the more closely together the rows of sewing, the harder are the buffs. The horsepower required for buffing is approximately 3 h.p. per in. width of buffed surface, when the wheel pressures are 10-15 lbs. per in. of face width. For previous work, see also *Metals and Alloys,* Vol. 9, Nov. 1938, p. MA 661 L/8. AB (7b)

Galvanizing Quality. R. W. SANDELIN (Atlantic Steel Co.) *Steel,* Vol. 103, July 4, 1938, pp. 44, 56, 61. Report of investigation. Appearance of hot-dip Zn coatings on strip or sheet is the criterion of quality used by the inspector in either the producer's or customer's mill. The causes of the dull gray surface spots, so frequently a cause of rejection, were investigated. 20 (commercial, semi-killed) steels were studied: 0.16-0.34% C, 0.31-0.64% Mn, 0.009-0.088% P, 0.024-0.050% S. Dull spots are shown to be areas where the Zn has alloyed with the steel base leaving dull gray Fe-Zn alloy at the surface. Production of gray spots therefore results from (1) any set of conditions that tend to produce a thin coating, such as slow emergence from bath or short immersion time and high bath temperature, or (2) conditions that tend to accelerate diffusion, such as high temperature of emerging strip or warm mill temperature. The most important single factor affecting spotting was found to be the type (not necessarily composition) of steel employed; the influencing factor is the rate of diffusion of Zn into the steel. Neither P nor C content had any significant connection with spotting. Pickling only intensified the spotting or non-spotting characteristics of the steel. Steels that spotted were found, however, to have a much smaller grain size than non-spotting steels, with a carbide structure ranging from normal to slightly abnormal; average grain size, therefore, not normality, is the important factor. Coarse-grained abnormal steels with high dissolved O content were non-spotting as compared with fine-grained normal steels with less dissolved O, which spotted. MS + FPP (7b)

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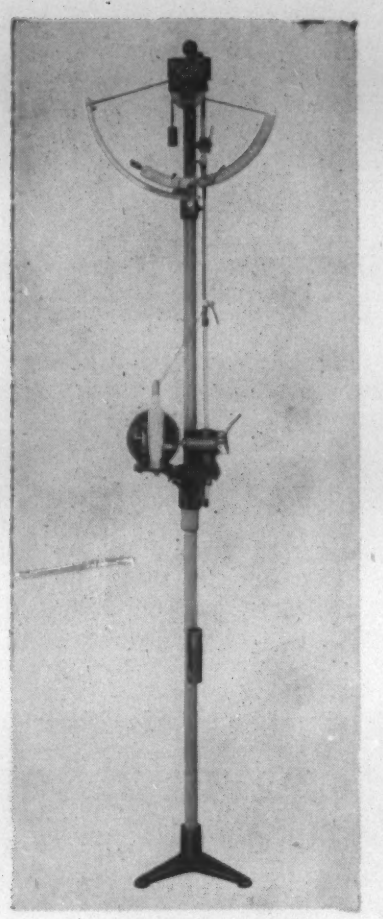

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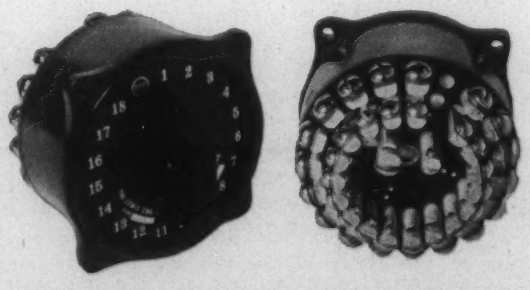

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Fish Scale Formation in Enamel (Die Fischschuppenbildung im Email) WALTER KERSTAN. Reprint from *Sprechsaal*, No. 27-30, 1938, Verlag der Sprechsaal, Coburg 1938, 61 pp. Original research. The practical opinions of numerous enameling plants are first given. The finest cracks in the enamel are really fish scales of smallest dimensions. All fish scales reach to the sheet surface. Surface cracks may be deepened fish scales. The different sheet brands commonly applied in Germany, made of Armco ingot Fe, open hearth and basic Bessemer steel, were used in the tests after chemical, physical and metallographic examination. The sheets were either normalized or box annealed. The different steel brands showed differences in their tendency to fish scale formation, when applying the same type of enamel. Prolonged pickling brought no increased tendency to fish scaling. Use of pickling inhibitors had no pronounced effect on fish scaling. To a large extent the defect could be decreased by sand blasting the sheets, evidently because of the coarser surface. The furnace atmosphere has a pronounced effect. Reducing atmospheres are highly detrimental. The formation of adhering layers is suppressed by the presence of CO. By suitable mill additions the ground enamel within certain limits can be made more resistant against fish scale formation. The most favorable amount of additions can be determined by experiment in every single case and depends on the composition of the enamel. Enamels inhomogeneously melted develop fewer fish scales. Firing at too high temperature and prolonged firing at high temperature promotes formation of fish scales. 850° C. is the most suitable temperature. Retarded firing at this temperature brings about a completely developed adhering layer but, at the same time, the enamel itself is inhomogeneous. Vacuum-annealed sheets possess much fewer fish scales than those not so treated. However, vacuum-annealed sheets possess fish scales to a large extent when enameled in a muffle with reducing atmosphere. The structural changes in the sheets during enameling may have a bearing on the defect, in that CO is formed through decarburization of the sheet surface. Not only the H_2 absorbed in pickling but also the H_2 developed by H_2O decomposition during enameling has a bearing on fish scale formation. Stresses within the enamel, particularly when caused by layer-like structure of the enamel, may bring about the defect. Crystal formation in the ground coat leads to fish scales, but, by adding alkaline borates to the mill, the defect can be decreased considerably. A finely roughened sheet surface greatly lessens fish scaling. In general, several of the mentioned causes act together simultaneously to bring about the defect. [In the opinion of the abstractor who has carefully watched the progress of this investigation, because of his own personal interest in the problem, Kerstan's investigation and that of Hoff and Klärding (see following abstract) will prove to be classic contributions to the solution of a familiar, yet little understood, enameling problem.—G.N.] GN (7b)

Connection between Gas Evolution and Fish Scaling in Enameling (Zusammenhang zwischen Gas- und Fischschuppenbildung beim Emaillieren) H. HOFF & J. KLÄRDING. *Stahl u. Eisen,* Vol. 58, Aug. 25, 1938, pp. 914-916. Original research. The gases evolved upon heating enamel slips by themselves or mixed with steel chips were determined and found to consist mainly of CO_2, H_2 and steam. During thorough drying, the enamel slips gave off about 1% by weight of chemically combined H_2O. Upon melting the slips, steam and CO_2 are given off. Upon heating a mixture of enamel slip and steel chips to red heat, the steam is decomposed by the Fe, and the H_2 content of the evolved gases rises to over 80%. This H_2 diffuses readily into a steel enamel solidifies. The gas pressure thus set up is considered to be a main cause of fish scaling. The tightness of the enamel and sheet in enameling; on cooling it cannot be given off after the the amount of burning-in play secondary roles. SE (7b)

Pretreatment of Metal Surfaces for Painting. F. N. SPELLER (Natl. Tube Co.) *Ind. Eng. Chem.,* Vol. 30, Oct. 1938, pp. 1152-1156. Practical. Recent tests and experience indicate that, as a rule, the most desirable preparation of steel surfaces for painting, particularly for under-water service, is complete descaling, followed by chemical treatment, such as washing with phosphoric acid-chromate solution. The principal factors that influence adhesion of paint film to metal surface are discussed. The sub-committee (XXIX of Committee D-1) of the A.S.T.M. on Preparation of Iron and Steel for Painting, is recommended as a good group to evaluate all the factors involved. 23 references. MEH (7b)

The Mutual Displacement of Metals from Vapors of their Salts and the Application of this Process in the Fight Against Corrosion. N. A. TZGARISHEW & E. S. SARKISOV. *Zhur. Obshch. Khim.,* Vol. 8, No. 9, 1938, pp. 830-833. In Russian. The precipitation of Cr on Fe from chromium chloride vapor is investigated. A highly corrosion resistant coating is obtained by treatment at 1100° C. in 4 hrs., followed by annealing for 3 hrs. at 875° C. A durable coating can also be obtained by joint precipitation of Cr and Ni, as well as W, from vapors of their salts. NA (7b)

8·TESTING AND CONTROL

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

The Impact of Beam. ZIRO TUZI & MASATAKA NISIDA. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1053-1079. In English. Original research. (For previous work see also *Metals and Alloys,* Vol. 6, Sept. 1935, p. MA 368 R/8; Vol. 7, June 1936, p. MA 308 L/1.) It was previously found that photo-elastic, experimental results do not coincide exactly with theoretical deductions and that some complicated vibration existed in the specimens. In the present paper, more precise observations on impact phenomena were made. Beams of steel, Cu and Al were supported at both ends and struck at the center by a hammer of different weights and falling from various heights. The displacements of the hammer and the beam were photographed with a high speed rotating camera having a resolving power of 1/80,000 sec. Hammer and beam collided several times during a short duration, which might be regarded as a single blow in classical dynamics. Beam and hammer are never in continued contact. The manner of contact is independent of the material of the beam or of the height of fall, and is affected only by the ratio of the weight of hammer and beam. The experimental results are in disagreement with classical dynamics, but agree with a theory taking into account the free and forced vibration of the beam and the local indentation at contact point. EF (T-8)

Measuring Internal Stresses by Means of X-rays (Messung innerer Spannungen mit Röntgenstrahlen) FRANZ WEVER. *Umschau,* Vol. 42, Oct. 23, 1938, pp. 978-981. Descriptive. The older, mechanical process for determination of internal stresses measures the deflection of pieces whose state of equilibrium was disturbed by a saw-cut or the like. The new method measures the stress directly without damaging the test piece, as elastic deformation of the lattice. It is accurate even if plastic deformation exists at the same time. Its limitation is that it records only superficial stresses. The reflection principle is used. The diameter of the interference circles is compared with that of an unstressed comparative material of known lattice constant, such as Au or Ag dust. Only 3 pictures are needed to determine the size and location of the principal stresses. Practical experience has proved that the X-ray method usually delivers somewhat higher stress values than the mechanical method if the surface is under stress. The mechanical method gives average values over the cross section; they may easily be too low. The X-ray method is therefore more reliable and practical. RPS (T-8)

Suggested New Definitions for Proportional Limit and Yield Point. L. H. DONNELL. *Mech. Eng.,* Vol. 60, Nov. 1938, pp. 837-838. Discussion. The inadequacy of the present definitions, because of present greater refinement in measuring method, is explained and it is proposed to express the stress at which plasticity first appears, the proportional limit, by $\sigma_{p1} = 1.5\sigma_{3/4E} - 0.5\sigma_{1/4E}$, and the yield point by $\sigma_{y1} = 1.5\sigma_{1/4E} - 0.5\sigma_{3/4E}$, where $\sigma_{1/4E}$ and $\sigma_{3/4E}$, respectively, designate the stresses at which the stress-strain slope is 1/4 and 3/4 of the original slope E. For materials such as structural steels, these formulas give values close to the proportional limit as usually indicated, and to the true yield point. For materials that have no true proportional limit or yield point the formulas give values for points in the stress-strain relation of the material closely approximating actual conditions. The application and usefulness is demonstrated, especially for Al and Al alloys. Ha (T-8)

Determination of Expansion Coefficients by the Powder and Rotating Crystal Methods (Die Bestimmung von Ausdehnungskoeffizienten nach der Pulver- und der Drehkristall-Methode) M. STRAUMANIS, A. IEVINS & K. KARLSONS. *Z. anorg. allgem. Chem.,* Vol. 238, July 1, 1938, pp. 175-188. Experimental. Linear and crystallographic expansion coefficients may be determined with a precision equal to or exceeding that of other methods for temperatures below 70° C. by operating the X-ray diffraction cameras in thermostats in which the temperature is maintained constant to about 0.03° C. The expansion coefficients of various salts and very pure Al were determined and compared with values in the literature. HFK (T-8)

Conversion Relations for Brinell, Rockwell and Vickers Hardness Numbers (Umrechnungsbeziehungen zwischen Brinell, Rockwell und Vickershärtezahlen) H. v. WEINGRABER. *Tech. Zentralblatt prakt. Metallbearbeit.,* Vol. 48, Oct. 1938, pp. 741-742. Original research. The Rockwell C hardness values deviated among themselves to the greatest extent, followed by Brinell hardness numbers determined on different machines. The deformation of the steel balls is blamed for this. Using a tungsten carbide ball improves the reliability of the readings considerably. The harder the test piece, the smaller the penetration of the Rockwell diamond cone and the greater the error due to slight variations of the contour of the tip of the penetrator. The author presents in graphical and tabular form conversions for all 3 hardness scales; the following formula covers the Brinell H_n and Vickers hardness H_p units only: $H_n = H_p$ (for H_n equal to or less than 300), $H_p = 1.2\ H_n - 60 = 1.2\ (H_n - 50)$ (for H_n equal to or more than 300), and $H_n = 0.83\ H_p + 50$ (for H_p equal to or more than 300). The conversion relations derived are valid for steel only and do not hold for non-ferrous metals. EF (T-8)

Gamma Radiation for Non-destructive Testing of Materials (Die Gammadurchstrahlung als zerstörungslose Werkstoffprüfung) O. TH. KORITNIG. *Oberflächentech.,* Vol. 15, Oct. 4, 1938, pp. 189-190. Review. The effect of γ radiation from radioactive elements is stronger than that of X-rays, for γ-rays have a shorter wave length and, therefore, greater penetrating power. Cu alloys of about 150 mm. and steel of 200 mm. thickness can be examined with them and still show defects clearly, but require exposures up to 100 hrs.; the distance of the sample from the source of radiation is about 70 mm. The procedure is explained in detail, and means for shortening the time of exposure are discussed. The present most-used radioactive element is mesothorium, as it is cheaper than Ra. The γ-radiation method is recommended only for pieces of large dimensions. Precautions to be observed both in evaluating the film and for protection against the harmful physiological effects of the rays are briefly mentioned. Ha (T-8)

New Manual Hardness Tester (Neuer Handhärteprüfer) *Tech. Blätter,* Vol. 28, Sept. 18, 1938, p. 560. Description of a new patented Rockwell hardness tester, developed by Dr. Müller of Focke-Wulf Airplane Works at Bremen, that weighs 1 kg., making possible hardness measurements on large pieces that cannot be tested by rigidly located hardness testers. Vickers determinations can also be made with this apparatus. [The abstractor tried one of the first models of this new apparatus and found the hardness readings in good agreement with other modern Rockwell hardness testers, such as the German tester made by Reicherter, Esslingen.—G. N.] GN (T-8)

Theories and Experiences on the Internal Damping of Materials (Teorie ed esperienze sullo smorzamente interno dei materiali) R. GIORANNOZZI. *L'Aerotecnica,* Vol. 28, Oct. 1938, pp. 1095-1133. Mathematical discussion and correlated abstract of published work on damping. The bibliography is to be published later. It is necessary to test materials in exactly the condition of service to secure information of greatest engineering value. HWG (T-8)

Quantitative Spectrum Analysis, in Particular the Determination of Vanadium in Steel (Die quantitative Spektralanalyse, insbesondere die Bestimmung von Vanadin in Stahl) J. WILKEN. *Arch. Eisenhüttenw.,* Vol. 12, Sept. 1938, pp. 133-140. Original research. Suitable lines for determining the V content in steel are given. A spectrograph with high resolution must be used. SE (H-8)

Tension-impact Testing. D. S. CLARK & G. DÄTWYLER. *Mech. Eng.,* Vol. 60, July 1938, p. 559. An arrangement of an Izod pendulum-impact machine in combination with an oscillograph is described that records the tensile forces acting on the specimen during the short time of the impact as electrical voltage changes in a force-time diagram. From this force-elongation and stress-strain diagrams may readily be obtained. Ha (T-8)

Non-destructive Thickness Measurements. *Metallurgist (Suppl. Engineer)* Oct. 1938, p. 165. Brief review, with extended abtract of paper by A. Trost in *Stahl u. Eisen.* See *Metals and Alloys,* Vol. 9, Oct. 1938, p. MA 616 L/6. VVK (T-8)

Quantitative Spectrographic Analysis. Standardization of Technique. D. M. SMITH. *Metal Ind., London,* Vol. 53, Nov. 18, 1938, pp. 485-488. Discussion of standardizational technique and development of methods suitable for routine analysis. The usual modes of excitation of spectra are the arc, spark and flame, or modifications of the same. As a preliminary to chemical analysis, a rapid spectrographic examination may save a considerable amount of trouble. Quantitative analysis may be made by the following methods: Comparison sample, internal standard, auxiliary spectra, auxiliary alloy, synthetic spectra, logarithmic sector, stepped sector and non-recording microphotometer. Each method is described. The analysis of pure metals is still the best example. With the provision of reliable standards for comparison and calibration purposes, it is a comparatively easy matter to standardize a routine method capable of giving results that are more reliable and consistent than those of routine chemical analysis. For routine examination of high purity materials, it is doubtful whether the extra time involved by the use of the microphotometer is justified. Where one is dealing with the third to fifth place decimals, the one significant figure obtained by visual interpretation of the spectra is in all probability a sufficiently definite indication of the information required. In testing to specifications in many cases the only information required is that a certain limit is not exceeded; the spectrograph gives all the information necessary for such work, and the exact composition is unimportant. 28 references. RWB (H-8)

Testing of Clad Steel Sheets (Prüfung plattierter Stahlbleche) W. RÄDEKER. *Stahl u. Eisen,* Vol. 58, Oct. 27, 1938, pp. 1153-1160. Practical. To determine the adhesion of the clad layer, 2 pieces of the sheet were cut and the clad layers strongly soldered together. The base portions were then welded to rods forming a tensile specimen when machined, the 2 bonding surfaces to be tested being toward the middle of the reduced gage length. This afforded a tensile test of the bond between the clay layer and the base. Bend, impact and metallographic tests are also described. SE (T-8)

Artificial Radioactivity as a Test for Minute Traces of Elements. G. T. SEABORG & J. J. LIVINGOOD (Univ. Calif.) *J. Amer. Chem. Soc.,* Vol. 60, Aug. 1938, pp. 1784-1786. Research shows how it is possible to detect and identify very small amounts of impurities by means of their characteristic half-lives, after the substance containing the impurities has been rendered radioactive by bombardment with charged particles of high energy or with neutrons. With the help of chemical analysis after the bombardment, impurities present to the order of one part per million can sometimes be detected. A gallium impurity of 6 parts per million was found in a sample of Fe. Without chemical analysis, one part in 1,000-10,000 can usually be detected. MEH (H-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Fatigue Bending Strength of Fillet and Butt Welds (Dauerbiegefestigkeit von Kehl und Stumpfnahtverbindungen) A. THUM & A. ERKER. *Z. Ver. deut. Ing.,* Vol. 82, Sept. 17, 1938, pp. 1101-1106. Research. The fatigue strength of sheets of 15 mm. thickness and 500 mm. width, welded perpendicularly to another sheet either by a fillet or butt weld, was investigated, with attention given also to different subsequent treatments. Both types of welds had originally a bending fatigue strength of 13,000-14,000 lbs./in.^{2} Milling in the weld increased the strength to 20,000 lbs./in.^{2} for fillet and to 22,000 lbs./in.^{2} for butt welds. Interior stresses caused by the welding process have a very slight effect on the bending fatigue strength, so that stress-relief annealing resulted in practically the same fatigue strength as the original. Cold-deformation by hammering gave no improvement. The bending fatigue strength of the welded seam worked down to sheet thickness was the same as that of the parent material. Ha (8a)

Effect of Surface Decarburization and Prior Heat Treatment on the Endurance Properties of Stretched Steel Wire (Einfluss von Randentkohlung und Wärmevorbehandlung auf Dauer- und Zeitfestigkeit von Stahlspanndrähten) F. BOLLENRATH & W. BUNGARDT. *Arch. Eisenhüttenw.,* Vol. 12, Oct. 1938, pp. 213-218. Original research. Patented and heat treated wire of the

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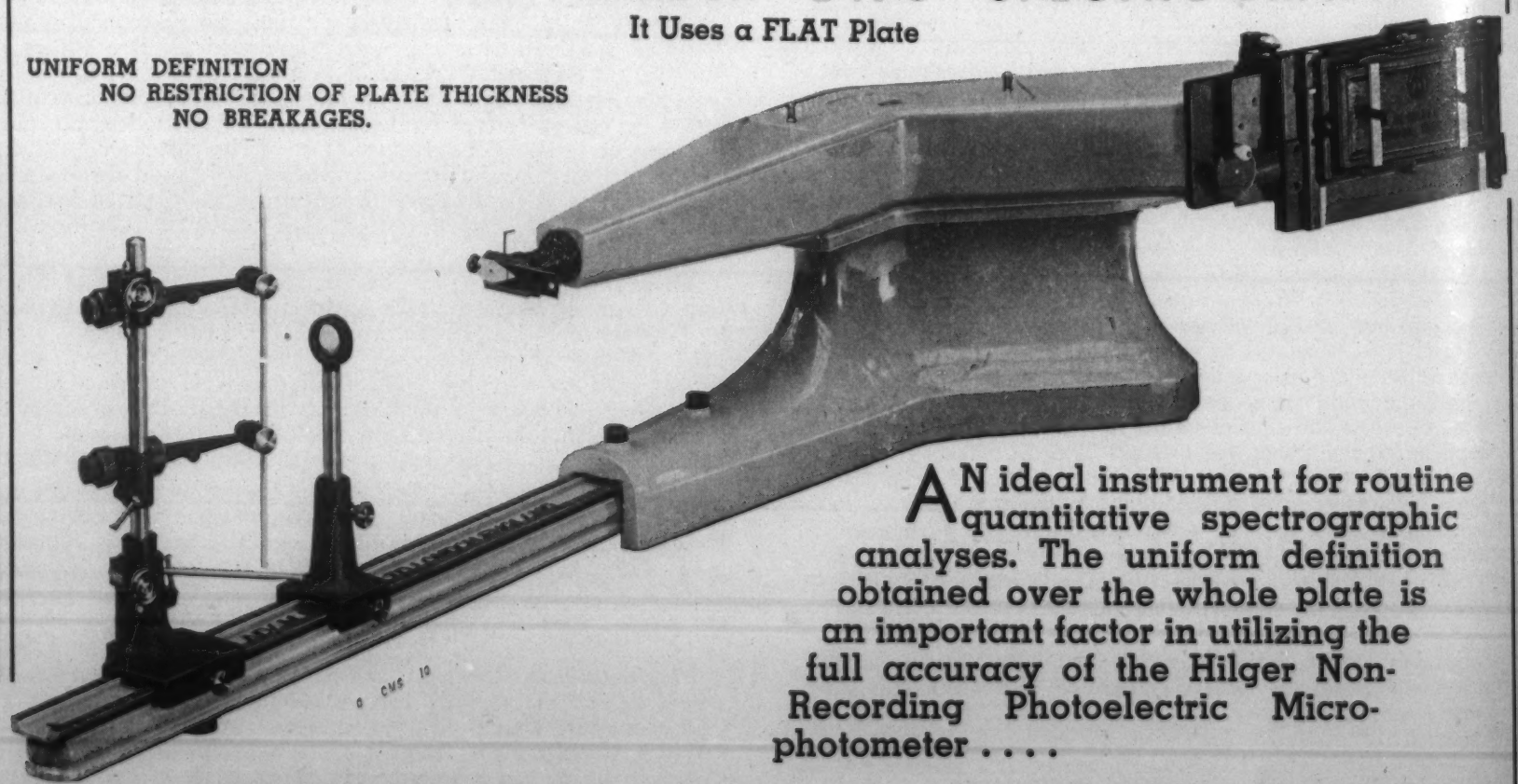

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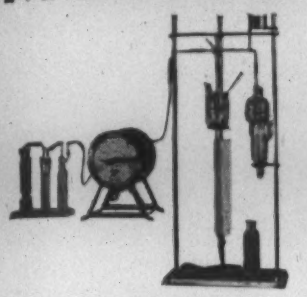

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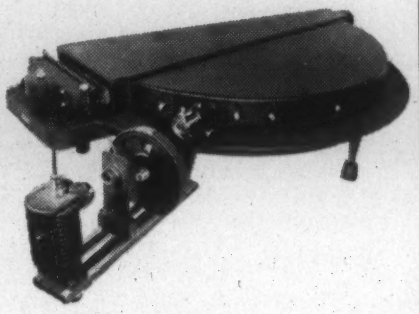

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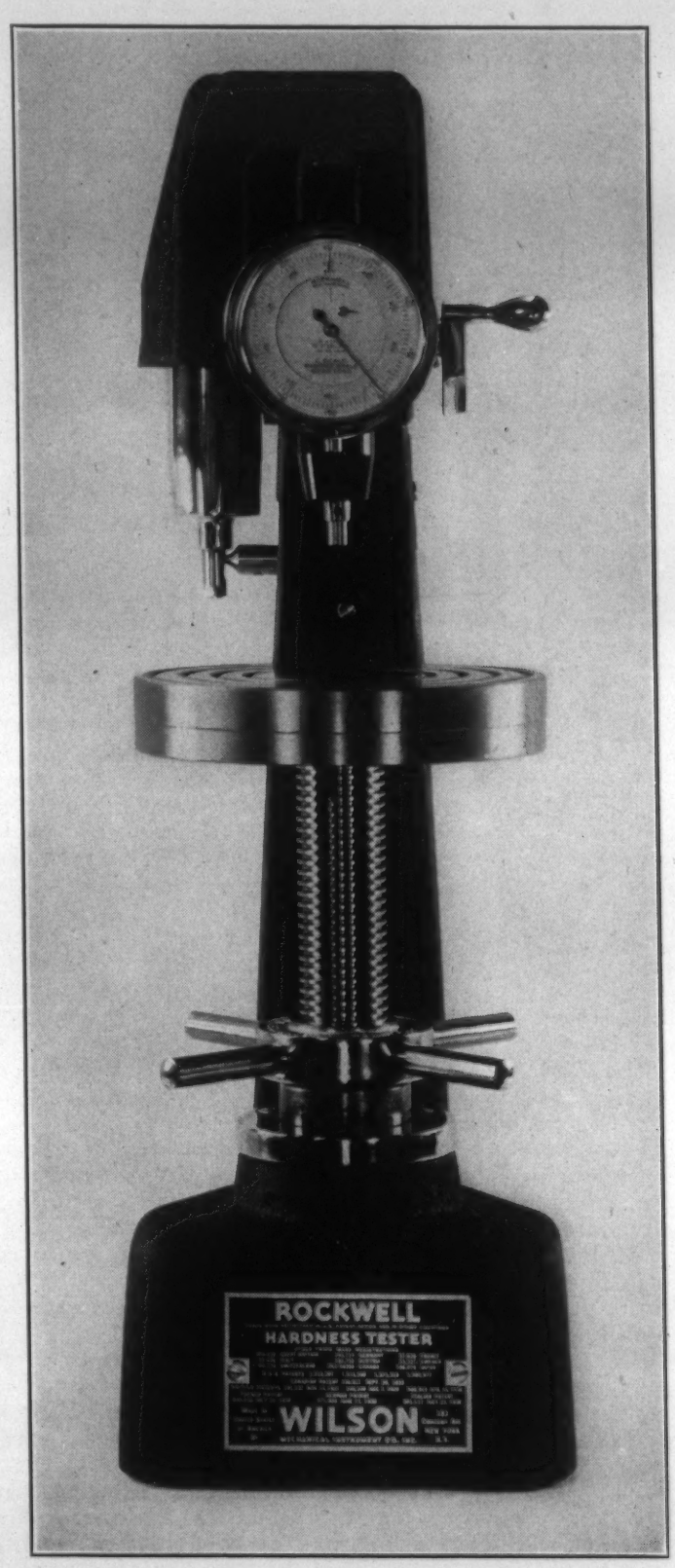
type used for stream line wire for airplanes, of about 0.45% C steel, and also of 0.26% C, 0.95% Cr, 0.26% Mo steel were tested in bending and torsional endurance tests. The endurance properties were definitely injured by surface decarburization. The endurance properties were improved by heating to about 250° C. after cold drawing. The endurance properties of the Cr-Mo steel wire were better than of the C steel wire, particularly in the heat treated state. The Cr-Mo steel was found to be more suitable for streamline wire, giving greater security and weight saving.

SE (8a)

Flash Welding of Rails. H. C. Drake (Sperry Products, Inc.) *Welding J., N. Y.,* Vol. 17, Oct. 1938, pp. 17-21. Descriptive. A special train is sent out for welding along track. The train consists of locomotive for steam generation, car with 2 turbo generators for welding current, flash welding car, car with furnace for stress-relieving weld and adjacent rail, also grinders for finish grinding weld, and other cars for lining up rail. Rail has been welded in lengths up to 1400 feet. The aim of this process of welding is to produce a joint comparable to the rail itself in hardness, tensile strength, strength under the drop test, and resistance to repeated stress. The question of resistance to repeated stress is considered to be of prime importance in view of the fact that for several years an average of about 10,000 failures or incipient failures from internal fissures are found annually on the railroads of the U. S. and Canada. The fatigue behavior of full-section welded rail joints was determined with an H. F. Moore rolling-load testing machine (see "Progress Report of the Joint Investigation of Fissures in Railroad Rails, *Proc. Am. Ry. Eng. Assn.,* Vol. 36, 1935, pp. 1065-1090; see also *Metal Progress,* Vol. 28, Nov. 1935, p. 46.) This testing machine subjects the rail specimen and the weld not only to bending moment but also to heavy wheel load, which seems the most important factor in developing internal fissures. The development of fissures during a rolling-load test is determined by an electrical drop-of-potential method (the Sperry "hand test"). The effect on resistance to repeated stress of stress relief and removal of flash by grinding was studied. The most effective stress-relieving treatment used was: (1) air cool for 3½ min. after welding, (2) heat to 1250° F. in 3 min. in an oil fired furnace, (3) remove from furnace and cool under an asbestos covering to 600° F. in 20 min., (4) cool in air. Data on rolling-load and other tests are given together with cuts of typical failures.

WB + HFM (8a)



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9 · METALLOGRAPHY

Structure and Constitution. Metallographic Equipment.

J. S. MARSH, SECTION EDITOR

Gases and Metals. COLIN J. SMITHELLS. *Foundry Trade J.*, Vol. 59, Sept. 1, 1938, pp. 159-162. Review plus original research. Gases may be present in a piece of metal, as (a) surface gas, (b) blowholes, (c) true solution and (d) in combination. Of the common gases, H_2 is the most readily soluble in a large number of metals. O_2 more frequently gives rise to a definite oxide phase. N_2 is soluble in a limited number of metals, and although there is evidence of simple solubility in some cases, all metals that dissolve this gas are known to form nitrides under suitable conditions. Compound gases can diffuse into metals only after dissociation. As a rule, these gases give rise to at least one compound. The oxides of C may yield both oxides and carbides in the metal, hydrocarbons give rise to dissolved H_2 and a carbide phase, water vapor breaks down to H_2 and an oxide phase. True solution is an endothermic process, and solubility therefore increases as the temperature is raised. Solubility should be related to temperature by an equation. $S = Ce^{-E_S/2KT}$ where C is a constant and exponent E_S represents the heat of solution. X-ray pictures show that as H_2 is absorbed the lattice of the metal gradually expands, and although the exact positions of the H atoms are unknown, they must presumably be interstitial. H_2 does not in any case give rise to a compound that separates as a distinct phase visible under the microscope. When Cu melted in air is allowed to freeze, the excess O_2 in solution is precipitated as a Cu-Cu_2O eutectic, and 2 phases are present in the solid metal. The Ag-O system presents some unusual features. The solubility temperature curve has a minimum at about 400° C., increasing again at both higher and lower temperatures. This means that the heat of solution is positive below 400° C. and negative at higher temperatures, and suggests that O_2 is mainly present as Ag-O below this temperature, and as dissolved O_2 above 400° C. If Ag is first saturated with H_2 and then heated in O_2, it is embrittled, O_2 diffuses-in much faster than H_2 can diffuse-out. In all cases of simple solution the absorption of gases is proportional to the square root of the gas pressure. In cases of compound formation, there will be an upper limit to the solubility, corresponding to the composition MH_n when the metal is saturated, and further increase in pressure will not result in increased absorption. H_2 alone diffuses so rapidly through most metals near their melting points that it can seldom develop as bubbles and blowholes. O_2 alone is usually precipitated as oxides when cooling leads to supersaturation. It is only when both these elements occur together, as they always will in the absence of special precautions during melting, that unsoundness results. An interesting discussion of a rimming steel ingot is given. During the solidification of such an ingot, a considerable amount of gas—CO and CO_2—is evolved and bubbles up through the molten metal. Analysis shows that the gas in the blowholes is mainly CO. AIK (9)

The Super-microscope (Das Übermikroskop) B. v. BORRIES, H. RUSKA & E. RUSKA. *Chem. Ztg.*, Vol. 62, Aug. 6, 1938, pp. 561-565. The super-microscope allows a magnification of 30,000 as compared with 2,000 maximum of an optical microscope. The definition is so good that it allows an additional optical magnification up to 4 or 5 times. The total magnification amounts to about 100,000. The principle of the invention is to work with rays whose wave length is much smaller than the light rays, *i. e.* cathode rays. The "lens-system" consists of coils enclosed in cases shaped like pole shoes, giving very small focal lengths. The rays become visible by change in wave length, which is effected by means of a fluorescing screen. The cathode rays can also be used for exposing photographic film. It is necessary to enclose the object to be investigated, the screen and the light-sensitive plate in the vacuum. Locking the object into the vacuum takes only 1 min., the plate 2 min. Another distinction of the new device is that it shows the distribution of masses, whereas the optical microscope shows the distribution of colors and refraction index. Major fields of application have been in medical and biological research, although the super microscope has been used for investigation of dyes, ores and other pulverulent materials. [Its usefulness in metallurgical research has still to be proved. R. P. S] RPS (9)

Fundamental Processes of Recrystallization in Precipitation-hardenable Alloys (Ueber die Grundvorgange bei der Rekristallisation aushärtbarer Legierungen) H. BUMM & H. G. MÜLLER. *Metallwirtschaft*, Vol. 17, Aug. 26, 1938, pp. 903-910. Original research and theory. A recrystallization study of 7 ternary Fe-Ni-Cu alloys, containing Fe and Ni in the ratio of 59/41 with 0, 1, 2.7, 6.0, 8.1, 10.8 and 13.1% Cu. Coercive force and permeability measurements were used to determine the beginning and progress of recrystallization with X-ray transmission photograms being used occasionally to verify magnetic data. Electric resistance measurements were used to follow the course of precipitation of a Cu-rich phase. After annealing at 1000° C., the alloys were quenched and cold rolled 99% without intermediate annealing. Subsequently, the alloys were annealed at various temperatures from 300° to 850° C. for varying time intervals and tested. The decrease in stress associated with recovery causes a small decrease in resistance and coercive force and a small increase in permeability, while recrystallization sharply increases coercive force as well as sharply decreasing permeability. Slow recrystallization does not affect the electrical resistance, while decomposition of a solid solution does. The beginning of recrystallization was not the same for all alloys; there was a definite incubation period before recrystallization took place at a constant temperature. Once recrystallization had taken place the rate of increase in permeability or decrease in coercive force is a function of grain growth. In general, it was found that with a constant amount of deformation, increasing the temperature would decrease the incubation period for recrystallization and increase the rate of grain growth. As the Cu content of the alloys became higher, the recrystallization temperature and the incubation time were increased, while the rate of grain growth decreased. The alloy containing no Cu recrystallizes at 500° C., while that containing 13.1% Cu recrystallizes above 800° C. A comparison is made between the authors' study and analogous experiments on the recrystallization of salts. On this basis a general theory of recrystallization phenomena is advanced. GA (9)

The Crystal Structures of the Iron-palladium Superlattices. RALPH HULTGREN & CARL A. ZAPFFE (Harvard Univ.) *Z. Krist.*, Vol. 99, Aug. 1938, pp. 509-512. In English. Original research. Previously reported structures of FePd and $FePd_3$ are in disagreement with the authors' determinations. Debye patterns of a 51.9 atomic % Pd alloy quenched from above 700° C. show a face-centered cubic structure with atoms distributed at random. At 650° C. and below a tetragonal structure with superlattice was found. At intermediate temperatures, a mixture of the 2 patterns was present. At 600° C., $a = 3.825$ A.U., $c_o = 3.723$ A.U. and $c/a = 0.9664$. At low temperatures, c/a decreases; c/a also decreases with higher Pd content. It is remarkable that there is an increase of atomic volume on ordering. This may be connected with the change in magnetic properties. The FePd superlattice is more stable with an excess of Pd than at its theoretical composition. At 60 atomic % Pd, it is stable up to 775° C., while the 51.9 atomic % Pd sample decomposes at about 675° C. This is surprising, as perfect order can be present only at 50 atomic %. There is an $FePd_3$ ordered state of the same structure as $AuCu_3$, which is face-centered cubic. An expansion of the $FePd_3$ lattice takes place during ordering. In the disordered state $a_o = 3.837$ A.U.; in the ordered, $a_o = 3.840$ A.U. It also is not most stable at its theoretical composition; at 30 atomic % Fe it persists up to 775° C., and at 25 atomic % Fe only to about 675° C. A 2-phase region separates the 2 superlattices. EF (9)

Local Analysis and Micrography (Analyse Locale et Micrographie) P. COHEUR. *Rev. Universelle Mines*, Vol. 14, Sept. 1938, pp. 702-703. Descriptive review. Several examples show how a local spectrum analysis, made by directing a high-tension electric spark to a definite spot on a surface, can help materially to clear up doubts on composition or irregularities at the respective spot, which otherwise could not be obtained except by destructive methods. Crystallographic determinations can be made easily in this manner and be a valuable supplement to micrographic investigations. Ha (9)

Metal Crystals. An Examination of their Physical Characteristics. BRUCE CHALMERS. *Metal Ind., London,* Vol. 53, Sept. 9, 1938, pp. 243-246; Sept. 23, 1938, pp. 295-298; Sept. 30, 1938, pp. 323-325. Review. Of the 4 methods (condensation, freezing, electrolysis and recrystallization) of forming large metallic crystals, those of freezing molten metal and recrystallization have been used almost exclusively for experimental work. The orientation of a single crystal produced by careful annealing after straining is the same as that of the nucleus from which it grew, and shows a distinct preference for certain directions relative to the direction of application of stress; the orientation is not under control of the investigator. The possible residual effects of crystal boundaries and previous strain are not present in the solidification method. The orientation of the resulting crystal is approximately predictable from the direction of growth. 3 methods have been used for obtaining crystals of any desired orientation: (1) Cutting from large crystals in the required direction; (2) growing a single crystal in a glass tube provided with branches inclined at a variety of angles to the original direction of growth, and (3) the seeding method. The method of specifying structure by atom position is discussed in detail. Many, if not all, the properties of single crystals depend on the direction, in relation to the crystal axes, in which they are measured. Microscopic examination of the "pits" formed during etching gives some information on the crystal axes. This method is not easily susceptible to accurate measurement and has not been widely used. Another method is to observe the direction in which a beam of light is reflected by the surface of the etched specimen. A third method of determining the orientation without the use of X-rays consists in observing the surface markings that appear when single crystals are stretched. These markings are the intersections of definite crystallographic planes in which slip occurs. This method is destructive but can be used on wires that are too thin for optical reflection. The modulus of elasticity of single crystals depends on the direction of measurement, with a maximum value along one axis, and a minimum along another; the value of the polycrystalline metal lies somewhere between these 2 extremes. Measurements of this sort are difficult to make because most single crystals are soft. Plastic distortion of a single cylindrical crystal occurs as if it consisted of discs, each of which retains its shape, the discs sliding over each other. In metals having hexagonal structure, slip will take place only along the basal planes (001). The cubic metals are more complicated. In face-centered cubic metals, slip may occur on the (111) plane, while in the body-centered lattice, slip may be on the (110), (112) or (113) planes. In Sn with a tetragonal lattice, slip may occur on the (110), (100), (101) or the (121) planes. Furthermore slip will take place in these planes only in certain directions. Slip takes place in a given direction if the resolved shear force exceeds a value characteristic of the crystal. The normal component of that force has no effect on the force required to cause one plane to slide over another; the normal force exerts an influence in certain cases (Zn) where cleavage may occur instead of slip. Slip bands appear as: (1) A few widely spaced bands first, with subsequent slip taking place by new bands between them or (2) simultaneous formation of all the slip bands, with further slip taking place on the originally formed bands. Twinning cannot be described as either plastic or elastic distortion, because it is permanent and takes place suddenly, either under impact or when a sufficiently large force is applied. Twinned parts of the crystal must be regarded as having recrystallized into a new lattice as a result of displacement of the atoms from the original lattice by an applied force. In anisotropic materials, results obtained by experiments on polycrystalline samples depend on the distribution of orientation of crystallites in the specimen, and, therefore, on the previous treatment, mechanical and thermal, to which the specimen has been subjected. Measurement of directional properties in polycrystalline specimens give no indication of distribution of orientation. Investigations of optical properties of single crystals have little value in connection with fundamental properties of crystals. Magnetic properties show considerable variation with orientation. Available investigations on metallic diffusion in single crystals show that diffusion takes place more readily in some crystallographic directions than in others. The main problem that confronts those investigating metal crystals is to explain the mosaic structure, and the association of "glide" and work hardening. RWB (9)

X-ray Studies of Metals at Elevated Temperatures (Röntgenographische Untersuchungen von Metallen bei hohen Temperaturen) H. ESSER, W. EILENDER & K. BUNGARDT. *Arch. Eisenhüttenw.,* Vol. 12, Sept. 1938, pp. 157-161. Research. The change in lattice parameter with temperature of Pt, Au, Ag, Cu, Al, Ni, and Fe was determined. The magnetic changes in Ni and in Fe are stated to be accompanied by very slight inflections in the lattice parameter-temperature curves, but these are not shown clearly. The changes in the coefficients of thermal expansion with temperature were also determined dilatometrically, and the results by the 2 methods compared. SE (9)

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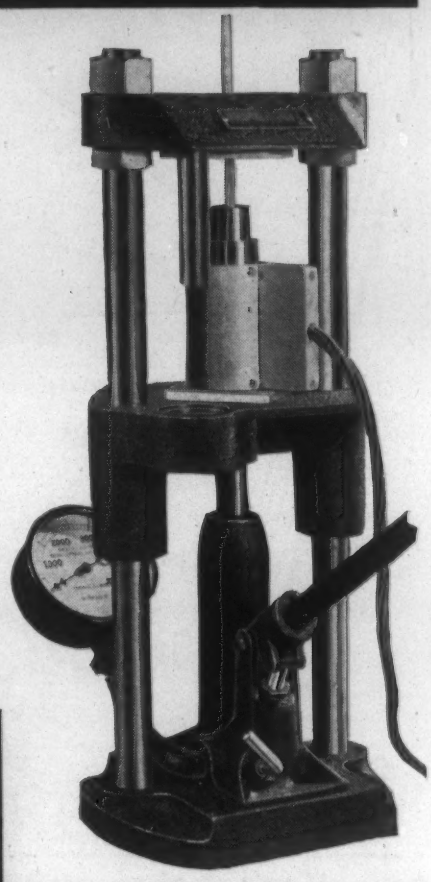

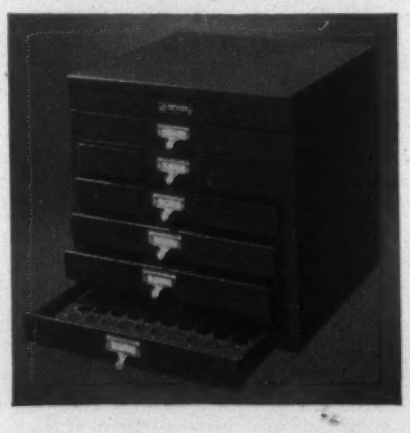

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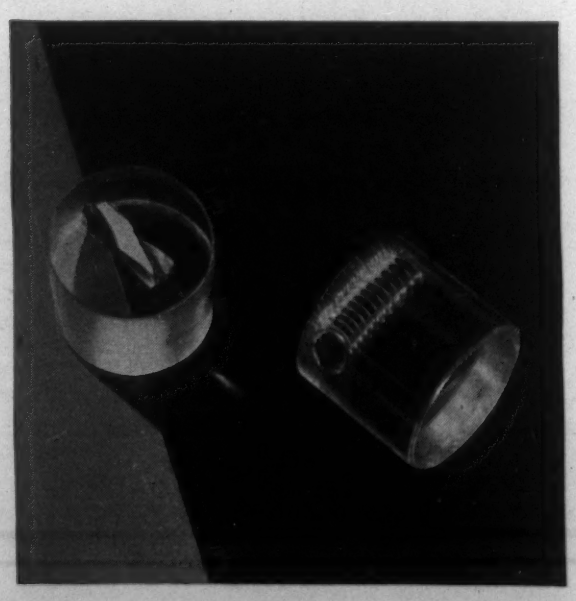

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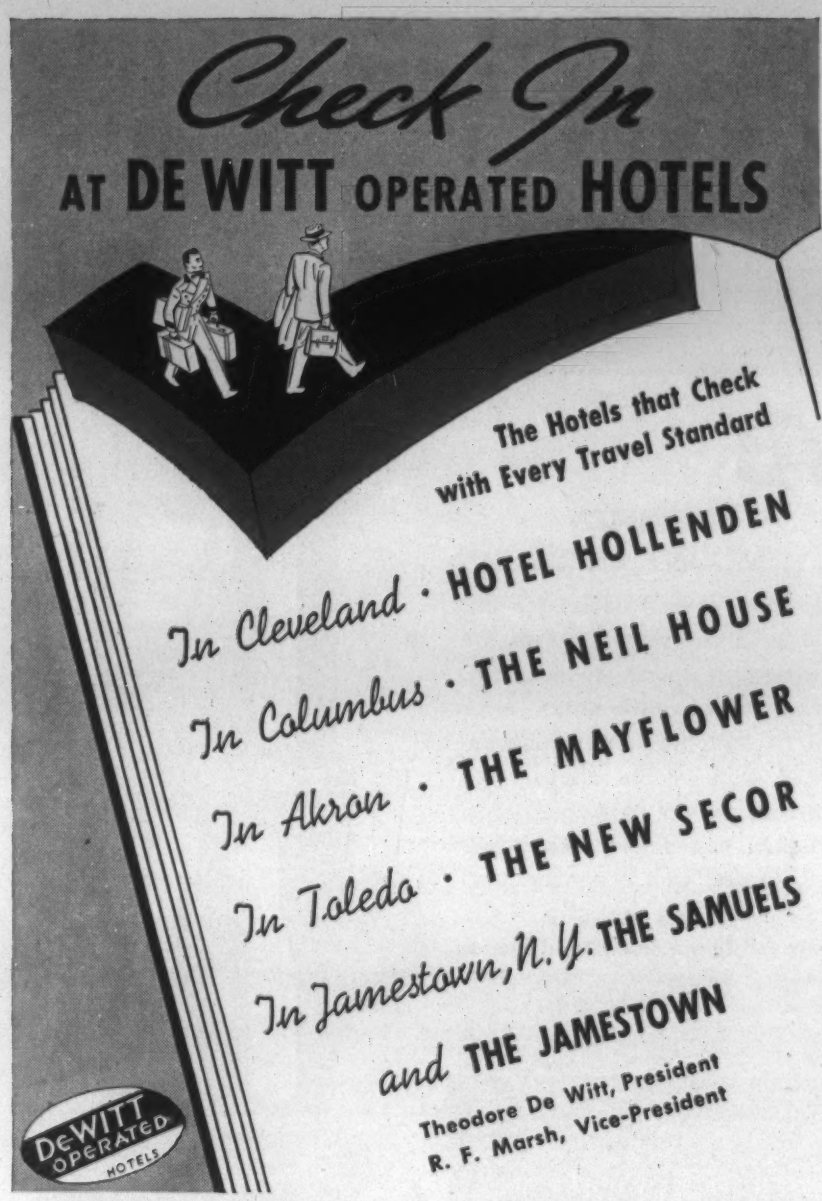

9a. Ferrous

J. S. MARSH, SECTION EDITOR

Polymorphic Transformation in Alloys of Iron with Arsenic and Antimony. V. N. SVECHNIKOV & V. N. GRIDNEV. *Metallurg,* Vol. 13, Jan. 1938, pp. 13-19. In Russian. Original research. The Fe-As alloys had 0.05% C and up to 4% As, while the Fe-Sb alloys contained 0.11% C and up to 4% Sb. The starting and ending temperatures of the $\gamma \rightleftarrows \alpha$ transformation were determined during heating and cooling. The Fe-As and Fe-Sb alloys belong to the systems with a closed γ field. The parameters were determined; As and Sb increase the parameter of α phase and also form solid solutions by interstitial filling rather than by substitution. BZK (9a)

Effect of Low Cooling Rates on the Transformation Temperatures of Carbon Steels (Einfluss kleiner Abkühlungsgeschwindigkeiten auf die Umwandlungstemperaturen der Kohlenstoffstähle) F. WEVER. *Naturwiss.,* Vol. 26, June 17, 1938, pp. 393-4. Review plus original research. Amount of undercooling of A_1 is only slightly affected by C content. With increasing cooling rates, the amount of undercooling rapidly increases to extraordinarily large values, i.e. with a cooling rate of only 0.01° C./sec., the equilibrium is shifted from 721° C. to 700° C. JZB (9a)

Influence of High Pressures on the Transformation of Carbon Steel. I. N. EFREMOV, YA. P. SLESISKII & P. I. GEORGIEVSKII. *Metallurg,* Vol. 13, Jan. 1938, pp. 20-24. In Russian. Original research. The decomposition of austenite in 0.87% C steel was investigated while cooling under pressure at various speeds. The steel contained 0.23 Mn, 0.21 Si, 0.008 P, 0.01% S. Under pressures of 280,000-330,000 lbs./in.^{2} martensite and troosto-martensite structures were formed. The use of lower pressures produced other metastable structures (troostite and sorbite). BZK (9a)

Grain Size and Structure of Steel at High Temperature. I. T. BARUZDIN. *Metallurg,* Vol. 13, May 1938, pp. 13-21. In Russian. Original research. The method consists of keeping the polished sample at 650°-1000° C. for 45 min. to 12 hrs. in a porcelain tube completely filled with dry dissociated NH_3 gas. Pressure in the tube is maintained at 30-90 mm. water even while the sample and the tube are being cooled. The austenite grains were visible on the whole sample surface, with the grain boundaries sharp and distinct. The time required for the test is ½ to ⅓ that for the McQuaid-Ehn test. BZK (9a)

The Iron-Iron Tungstide-Iron Titanide System (Das System Eisen-Eisenwolframid-Eisentitanid) R. VOGEL & R. ERGANG. *Arch Eisenhüttenw.,* Vol. 12, Sept. 1938, pp. 149-153. Research. The Fe-W-Ti system was studied thermally and microscopically in the composition ranges up to 50% W and 25% Ti, that is up to the sections Fe_3W_2-Fe_2Ti. These compounds form a continuous series of solid solutions. A ternary α solid solution of Fe_3W_2-Fe_2Ti separates out from the melt. The solid solubility line of this α constituent as well as the liquidus lines were determined. SE (9a)

Method of Determining Small Quantities of Residual Austenite in Steel. A. A. KUZNETSOV. *Metallurg,* Vol. 13, May 1938, pp. 28-33. In Russian. Original research. A method is described for determining small amounts of residual austenite in quenched steel by the differential measurement of saturation. For steel containing 0.41% C, 0.34% Si, 0.47% Mn, 0.017% P, 1.31% Cr and 3.12% Ni, the amounts of residual austenite after quenching in air, water, and oil from 850°-1100° were 5.4-3.5, 1.7-4.2, and 3.9-5.3% respectively. For steel containing 0.22% C, 0.33% Si, 0.33% Mn, 0.013% P, 0.85% W, 1.30% Cr and 4.34% Ni, the amounts of residual austenite after quenching in air and oil from 850°-1050° were 4.3-5.7 and 2.1-0.9%, respectively. BZK (9a)

Investigation of Alloys of the Iron-nickel-sulphur System. G. G. URAZOV & N. A. FILIN. *Metallurg,* Vol. 13, Feb. 1938, pp. 3-17. In Russian. Original research. The liquidus surface of the ternary system consists of 3 primary fields: (1) Solid solutions of metals, (2) solid solution of Fe and Ni sulphides and (3) FeS. Investigation of the system FeS-Ni_3S_2, containing 42.5% Ni, showed that by decreasing the temperature below the eutectoid the concentration of the ternary solid solution decreases. Its decomposition results in the formation of free metals and the compound $2FeS.Ni_3S_2$. No ternary eutectic was observed. BZK (9a)

Possibility of Measuring the Internal Stress of Cast Iron by X-rays. TOSHIO NISHIHARA & KOHEI KOZIMA. *Trans. Soc. Mech. Eng., Japan,* Vol. 4, May 1938, pp. 110-113. In Japanese. English abstract p. S-19. Original research. The same testing method previously used for the determination of internal stresses on the surface of a machine part made of pure Fe was applied to cast Fe. The inter-relation between internal stress induced by bending and lattice constant was experimentally established. A graphical presentation shows this inter-relation to be almost linear for cast Fe, although the accuracy of the results is not quite so good as with pure Fe. EF (9a)

9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

The Diffusion of Hydrogen Through Nickel. C. B. POST (Carpenter Steel Co.) & W. R. HAM (Penn State) *J. Chem. Phys.,* Vol. 6, Oct. 1938, pp. 598-605. Original research. The diffusion of H through commercial and very pure anode Ni was determined from 1100° to 150° C. The diffusion rates vary in a perfectly regular manner throughout this region, except for a discontinuity at the Curie point. The Rydberg series found in Fe has not been found in Ni. A very exact agreement with the formula $R = AT^Z p^Y x^{-b/T}$ was found in all cases. After very long heat treatment with H, resulting in decarburization, the value of Y in the above equation for anode Ni becomes +0.5 with the possible exception of a region within 3° of the Curie point. The magnetic transition of Ni as shown by diffusion is abrupt, the isobars below the Curie region being as straight as those above. There is always a sudden drop in the value b, as calculated from the simple equation $R = A^{-b/T}$ at the Curie point, that value changing in the purest Ni from 6600 to 5800 with rising temperatures. No systematic breaks appear in the isobars at high temperatures, such as are found in pure Fe, but, nevertheless, the value of z indicates that the diffusion of H possesses appreciable energy within the lattice. The Curie region shows marked hysteresis and is similar to the Curie region of pure Fe in this respect. Existing theories of ferro-magnetism seem to require modification inasmuch as the Curie transition in Ni appears to take place about as abruptly as the body-centered face-centered transition in Fe. A variation in H concentration in Ni near the Curie point does not markedly affect the latter. The loss of ferro-magnetism at 360° C. is essentially an atomic phenomenon and should not be associated with conditions in aggregates of atoms or atomic domains. During the Curie transformation, for a finite time, there appears to be an additional electron in the valence shell of some Ni lattice points. A possible description of the change from the ferro-magnetic to the para-magnetic condition in the transition elements is that an electron is moved from the 3d shell to one of the 4-levels followed more or less quickly by the drop of another 4-level electron back to such a 3d shell as to result in pairing of electron spins in the 3d shell. EF (9b)

X-ray Studies on Cobalt-tin Alloys and a Comparison of the Systems Co-Sn, Fe-Sn and Ni-Sn (Röntgenuntersuchung von Kobalt-Zinnlegierungen und ein Vergleich des Systems Co-Sn, mit Fe-Sn und Ni-Sn) O. NIAL. *Z. anorg. allgem. Chem.*, Vol. 238, July 1, 1938, pp. 287-296. Experimental. α-cobalt dissolves only a very small amount of Sn. At 1000° C. β-Co dissolves up to 2.5 atomic % Sn. Four intermediate phases exist in the system: A phase γ′ having a NiAs type structure with dimensions between $a_0 = 4.096$, $c = 5.161$ A.U. and $a_0 = 4.116$, $c = 5.177$ A.U. that contains 41-42 atomic % Sn. In this type of Co-Sn lattice are excess Co atoms in random distribution. Below 550° C. these atoms become ordered and γ′ changes to a superstructure phase γ, the structure of which is probably hexagonal with dimensions $a = 16.356$, $c = 5.198$ A.U. The third phase is CoSn, which is hexagonal with $a = 5.268$, $c = 4.249$ A.U. and has the same structure as PtTl. Space group D_{6h}^1 — C6/ mmm. The fourth intermediate phase is $CoSn_2$, which is tetragonal with $a = 6.348$, $c = 5.441$ A.U. Space group D_{4h}^{18} — 14 mcm. A revised diagram of the Co-Sn system is given. Comparison of the systems Fe-Sn, Co-Sn, and Ni-Sn shows that they have in common only a phase of the NiAs type. CoSn has an analogue in FeSn, but otherwise the 3 systems are different. HFK (9b)

The Indium-lead System (Ueber das System Indium-Blei) S. VALENTINER & A. HABERSTROH. *Naturwiss.*, Vol. 26, Aug. 5, 1938, p. 517. Research. Earlier results indicated a continuous solid solution, which seemed improbable, since Pb is face-centered cubic, and In is tetragonal. In and In with a little Pb have a face-centered tetragonal structure with $c/a = 1.08$. At 10 atomic % Pb a face-centered tetragonal phase with $c/a = 0.94$ appears, which increases until it is the only constituent at 20 atomic % Pb. At 27 atomic % Pb, the Pb lattice first appears, with a lattice constant that is only 2% smaller than that of pure Pb. Above 35 atomic % Pb, only the Pb lattice can be detected. JZB (9b)

The Manganese-vanadium System (Einige Beobachtungen am System Mangan-Vanadium) H. CORNELIUS, W. BUNGARDT & E. SCHIEDT. *Metallwirtschaft*, Vol. 17, Sept. 16, 1938, pp. 977-980. Research. Mn-V alloys containing from 0 to 80% V were investigated, using thermal analysis, microscopic examination and X-ray diffraction studies. All alloys, especially those with more than 90% Mn, are very hard and brittle. Solidification temperature rises with increasing V content until at 60% V it is over 1770° C. The solid solubility of V in Mn is about 5% at high temperatures. 3 compounds were found, and the structures of 2 determined. GA (9b)

The Phases $CoTe-CoTe_2$ and $NiTe-NiTe_2$ (Ueber die Phasen $CoTe-CoTe_2$ und $NiTe-NiTe_2$) S. TENGNER. *Naturwiss.*, Vol. 26, July 1, 1938, p. 429. Research. Both groups of phases cover a large range of compositions, since CoTe (NiTe) gradually goes over into $CoTe_2$ ($NiTe_2$) with increasing Te. As the Te content increases, there is first a scarcity of atoms in the lattice, then irregular empty spaces, and finally the original lattice of the NiAs type becomes one of the CdI_2 type. The same phenomenon may be noticed in the Ti-H system: With small amounts of H_2, the H atoms are situated between the Ti atoms, then with increasing H_2, Ti_2H, TiH, and TiH_2 are formed without any 2-phase regions in between. JZB (9b)

The Structure of Cr-Mo Alloys (Ueber den Aufbau der Chrom-Molybdän Legierungen) W. TRZEBIATOWSKI & H. PLOSZEK. *Naturwiss.*, Vol. 26, July 15, 1938, p. 462. Research. The melting point of Cr is 1770° C. (determined on samples sintered in H_2 at 1200° C. and then resistance-melted in vacuum). Cr and Mo form a continuous solid solution with a minimum in the liquidus at 15 atomic % Mo and 1700° C. The lattice constant increases practically linearly with composition. These results do not agree with some thermoanalytical results, which indicated a eutectic at 1460° C. between Cr and a Mo-rich solid solution. JZB (9b)

The Iron-zinc System (Ueber das System Eisen-Zink) H. BABLIK, F. GOTZL & F. HALLA. *Z. Metallkunde*, Vol. 30, Aug. 1938, pp. 249-252. Experimental. X-ray and goniometer studies of a single crystal of the δ_1 phase, containing about 8% Fe, showed the unit cell to have the dimensions $a = 12.80$, $c = 57.6$ A.U. with a space group C_{6v}^4 or D_{6h}^4, and to contain 550 ±8 atoms. The structure of $FeAl_3$ (*Z. Kristall.*, Vol. 88, 1934, p. 179) was also confirmed, with $a = 47.54$, $b = 15.485$, $c = 8.14$ A.U. GD (9b)

Relationship between Workability and Crystal Structure of Cubic and Hexagonal Lattices (Zusammenhänge zwischen Verarbeitbarkeit und Kristallstruktur von Kubischen und hexagonalen Werkstoffen) A. BURKHARDT. *Metallwirtschaft*, Vol. 17, Oct. 14, 1938, pp. 1083-1087. Descriptive. Compares the forming characteristics of Zn with Cu and Al. The effects of cold rolling, cold drawing, hot rolling and annealing are considered and related to characteristics of the lattices of the metals involved. GA (9b)

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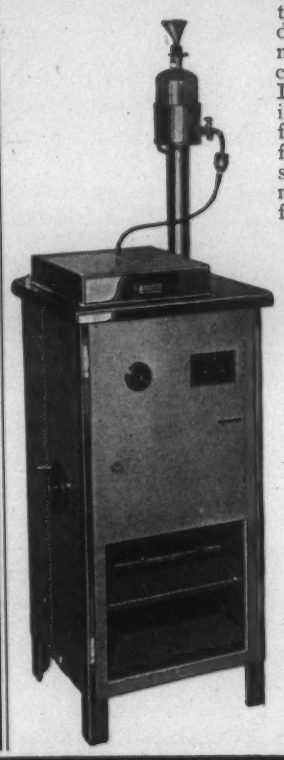

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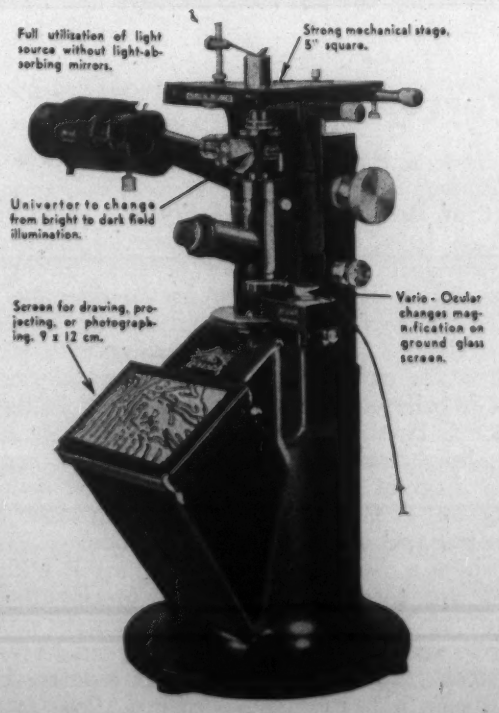

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10 · PROPERTIES AND APPLICATIONS

Including Relation of Properties to Engineering or Product Design. See also Sections 8a and 11.

M. GENSAMER, SECTION EDITOR

Cast Iron or Light Metal Casting (Grauguss oder Leichtmetallguss)? M. MAJER. *Giesserei,* Vol. 25, Aug. 26, 1938, pp. 424-427. Review. The factors to be considered in choosing between cast Fe and light metal castings are discussed; cast Fe is classified into 4 groups: Ordinary cast Fe (DIN 1691) with 2% Si, 0.7% Mn, 0.7% P, 0.1% S, tensile strength 23,000 lbs./in.², bending strength about 43,000 lbs./in.², Brinell hardness 120-160; cast Fe of better strength (DIN 1891), with 1.8-2% Si, 0.8% Mn, 0.5% P, 0.09% S, 26,000 lbs./in.² tensile strength, 51,000 lbs./in.² bending strength, hardness 150-180; special cast Fe (DIN 2691) with 1.6-1.8% Si, 0.8-1% Mn, 0.4% P, 0.08% S, 37,000 lbs./in.² tensile strength, 71,000 lbs./in.² bending strength, hardness 180-220; heat-resisting cast Fe with 2% Si, 1% Mn, 0.2% P, 0.08% Mn. These 4 groups are compared with 4 groups of light metals: Ordinary Al castings with up to 5% Cu, Zn, Si, and some Fe, Mn, tensile strength 17,000-24,000 lbs./in.², bending strength 50-80% higher, hardness 60-90; silumin castings with 11-13.5% Si, and remainder Al, tensile strength 24,000-31,000 lbs./in.², bending strength 50-80% higher, hardness 50-60; silumin-gamma with 11-13.5% Si, 0.4-0.6% Mn, 0.1-0.5% Mg, and remainder Al, tensile strength 36,000-43,000 lbs./in.², bending strength 50-80% higher, hardness 80-100; corrosion-resistant alloys, such as hydronalium or KSS, with 4-12% Mg, up to 1% Mn, 0.1-0.5% Si, and up to 1% Sb, 21000-28,000 lbs./in.², tensile strength, 50-80% higher bending strength, hardness 60-70. Material, weight, wear resistance and machinability all enter into the question of relative cost. Ha (10)

German Development of New Brake Linings (Beitrag über eigene Arbeiten zur Entwicklung von Bremsbelägen aus deutschen Rohstoffen) RUDOLF OSWALD. *Deut. Motor Z.,* Vol. 15, Feb. 15, 1938, pp. 54-56. Original. The object of the author's experiments was to replace asbestos fibre in brake linings by metallic wool. Al and steel wool (0.03 mm. diam.) is embedded in resin or synthetic rubber. The new linings are wear-resistant, rigid, heat-conducting and not more sensitive to oil and grease than asbestos base linings. EF (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

The Effect of Boron on Nickel Steels. *Metallurgist (Suppl. Engineer),* Aug. 1938, pp. 146-148. Correlated abstract of 6 references. Improvement in properties of steel through boronizing or direct alloying is usually sought in the direction of increased hardness, but the surface layer produced by cementation with ferro-boron is claimed also to confer resistance to acid attack and to high-temperature oxidation. The increased hardness of B-containing steels is believed due to the presence of Fe_2B, which forms with up to 8.8% B; the compound is more soluble in α-iron than in γ. Fe-B alloys contain a brittle eutectic that may be harmful. The B-Fe-Mn diagram at 2% Mn is similar in many respects to the Fe-C diagram, and B alloys on quenching show Brinell hardnesses up to 400 and are softened by tempering. The austenitic Cr-Ni steels show a diminishing solubility for B with fall of temperature, and are therefore subject to precipitation hardening. Small amounts of B raise the Brinell hardness, yield point and tensile strength, and reduce elongation and impact values of normalized Ni steels. In quenched steels, B re-inforces the hardenability of the steels. Reheating the quenched alloys at 50° C. brings a marked increase in tensile strength; reheating at 150-250° C. lowers the tensile strength of B-Ni steels below the as-quenched value. VVK + FPP (10a)

Cast High-chromium Manganese Steels. *Metallurgist (Suppl. Engineer)* Aug. 1938, pp. 158-160. Extended abstract of "The Influence of Manganese up to 20 per cent on the Structure and Properties of Cast Alloys with 30 per cent of Chromium." See *Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 731 L/5. VVK (10a)

Strong Trend Toward Use of Steel in Airplane Construction. *Steel,* Vol. 103, Sept. 5, 1938, pp. 15-17, 90. Survey. With the trend toward larger military and transport planes, stainless and heat-treated alloy steels are playing increasingly important parts. Some metallurgical engineers predict that stainless steel will soon be the most prominent metal in aircraft construction, and visualize the all-steel plane. Estimated requirements of stainless steel alone for a 4000- to 5000-plane year would be about 5000 tons, on the basis of present size. Steel comprises nearly 20% of the basic structural weight of a modern 21-passenger transport plane. The larger the plane, the greater the proportion of steel. Of the more than 2 dozen different kinds of steel used in present-day planes, most important in amount are the Cr-Mo and stainless steels. The former is used for highly stressed structural parts where welding is necessary and space is limited. The latter now are used primarily where corrosion resistance and heat resistance are the important factors. Ni steels are used for threaded parts. Among the latest developments are Ni-Cr-Mo steels, such as S.A.E. 4340 and 4345. Their excellent depth-hardening properties make them suitable for large sections. Steel castings are not widely used, but there are indications that their application may become more common. Ni alloys, particularly Inconel and K Monel, are receiving more recognition. Early disadvantages of Mg alloys have been overcome, but results of service tests in progress will decide how much will be used in the future. MS (10a)

X-ray Measurement of Stresses in Mild Steel after Exceeding the Yield Point in Bending (Roentgenographische Spannungsmessungen bei Überschreiten der Fliessgrenze an Biegestäben aus Flussstahl) F. BOLLENRATH & E. SCHIEDT. *Z. Ver deut. Ing.,* Vol. 82, Sept. 17, 1938, pp. 1094-1098. Research. The results of experiments, described in detail, indicate that in rods of various sections which were not stressed uniformly, partly below and partly beyond the flow limit, 3 ranges must be distinguished: (1) An elastic range of small dislocations, in which Hooke's law applies; (2) a transition zone in which the flow obeys the stress conditions, but where the dislocations are of the order of elastic deformations; and (3) a flow range where the flow conditions are valid for the stresses exerted, and the deformations can become very large. The flow limit under bending is no greater than under tensile stress and is independent of the section. The location of the neutral axis is not affected, irrespective of the bending moments causing stresses beyond the flow limit in some fibres. 9 references. Ha (10a)

The Nickel Cast Irons. A. B. EVEREST. *Foundry Trade J.,* Vol. 59, Oct. 6, 1938, pp. 253-254. Extended abstract. Review. Influence of Ni on cast Fe, types of Ni cast Fe, Ni in foundry, improvement of machinability, strength, hardness and wearing quality, heat resistance, magnetic properties, electrical properties and expansion properties are discussed. Ni is a graphitizer. It stabilizes the pearlitic matrix of the castings, and at the same time refines the structure and makes it more dense. Ni lowers the critical temperature so that progressive additions render the matrix of the Fe successively sorbitic, martensitic and, finally, austenitic. The austenitic cast irons are non-magnetic. The first Ni cast Fe developed in this connection was Nomag (Ni 12, Mn 6%). If Ni content is increased above that normally employed in this class of casting, the metal becomes magnetic again. The austenitic cast irons are of special value because of their high electrical resistance, this being 140 microhms/cm.³ AIK (10a)

Lightweight Development in Railroad Equipment Using High-tensile Steels. A. E. STUEBING. *Southern & Southwestern Railway Club Proc.,* Vol. 26, May 1938, pp. 8-28. Survey. The specific requirements of steel used in freight cars are explained, and the characteristics of the low alloy, high strength and Cu steels most commonly used are given in a table. The corrosion resistance must be high, especially as the plates are subjected at the same time to severe abrasion. Paint adheres better to the Cor-ten plates, for example, than to other materials, and cars made of this and similar steels give decidedly better service than standard steel cars. In corrosive atmospheres, Cor-ten has from 2-3 times the life of Cu steel. Ha (10a)

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10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Light Alloys in Aircraft Construction. Recent Developments and Future Trends of Practice and Research. R. LE COEUVRE. *Metal Ind., London,* Vol. 53, Nov. 4, 1938, pp. 437-442. Presented before the Royal Aeronautical Society. Light alloys are being increasingly applied in aircraft construction, even in the face of constant improvement in heavy metals whose strength/weight ratio can at times exceed that of light alloys. *Recent Industrial Development:* In engines, Al alloys with 10% Cu were formerly used that developed 6½-7½ tons./in.², as-cast. Development of heat treatable alloys has increased this figure to 18½-21 tons/in.² Further development has made it possible to repair damaged crankcases by welding. Mg alloys have likewise been improved and good results have been obtained at temperatures up to 300° C. by additions of Ag and Ce. Equally important have been improvements in production methods, such as pressure die-casting for Mg and certain Al alloys for carburetor bodies, and press forging of pistons and other parts. Finer grain and generally improved characteristics are produced by subjecting parts to pressure, during solidification, in an autoclave. Aeronautical construction will tend more toward the use of sheet and strip for structural members. The method for assembling and mounting light metal parts can still be improved; replacement of the present cumbersome, stationary riveting machines by portable machines that will drill sheet and place and hammer the rivets will be an important improvement. Al-Mg alloys have superior salt water resistance and are easily weldable. Alloys of less than 7% Mg are heat treatable, amenable to deep drawing, may be worked hot or cold and easily welded. Their tensile strength is 20-23 tons/in.² with 25% elongation. Alloys of 7-9% Mg are somewhat stronger, may be worked cold or hot, but have a brittle range at 150°-350° C. Such alloys may be welded but the strength of the joint is inferior. Additions of Ti improve these alloys. Mg-base alloys are used as-cast for landing gears, wheels, supports, and various equipment while sheet is used for tank construction. The sheet material is easy to weld and develops 18-20.5 tons./in.² with 10-14% elongation. Owing to their corrodibility, however, Mg alloys must be protected, either by electrolytic or dichromate dip treatment, before painting. Welding offers a solution to the problem of producing water tight joints in seaplane hulls and floats, but does not overcome the danger of electrolysis. The use of less noble metals at points of contact has been suggested. Zn or Cd are suitable for this purpose, and may be conveniently applied by metal spray. *Trends of research:* Attempts to improve the mechanical properties while retaining the welding and stability properties are described. Difficulties with spot or seam welding of light alloys arise from the high electrical and thermal conductivities of the metal, relatively low fusion point, presence of oxides, and corrosion hazards caused by use of Cu electrodes and the necessity of changing the electrodes often. Excessive electrode pressure cold works the metal and will cause corrosion; if pressure is too low, pores and cracks are formed. Al-Mg alloys weld better than Dural. Industrially, heat treatment of Al-Mg alloy welds and stoving for protection could be simultaneously effected. Tests to produce watertight assemblies by seam welding have not given uniform satisfaction. Radiographic control of welds is an old, and when properly applied, very useful process. Research in automatically protected alloys, exposed to sea water, has been conducted for years. By addition to the Al base metal of suitably chosen constituents, the particles of which are finely divided, it is possible to obtain on the surface a continuous passive film. Invisible films, of a thickness less than the wavelength of visible light, are the most flexible, adherent and, consequently, the most protective. *Future industrial developments:* In the automotive field, the number of workers per unit per day has decreased from 110 in 1920 to 12 in 1936, through application of mass production methods. What has happened to the automobile can be extended to aircraft construction. In an average assembly, the working times are in the following ratio: Purely mechanical work 15%, semi-mechanical work 25%, assembly and mounting 60%. In an effort to reduce time of installation, the use of the following refinements might be applied: Exclusive use of weldable light alloys, power draw presses, electric welders, bend presses, welding machines, shears, band saws, planing machines, large heat treatment furnaces and large anodizing baths for treatment of assemblies. The use of the chignolle and the portable punch should be excluded. RWB + EF (10b)

Al and Its Alloys. F. A. Fox. *Machinery (London),* Vol. 52, Aug. 4, 1938, pp. 549-553; Sept. 1, 1938, pp. 673-676. Comprehensive review. Al alloys are used for (1) high electrical conductivity; (2) high thermal conductivity; (3) corrosion resistance; and (4) oxidation resistance. Solid solution type alloys are generally used for forging, while eutectic types are used for castings. Properties and composition of common English Al alloys are given. JZB (10b)

The Development of New Uses for Silver. A. J. DORNBLATT. *Mining Congr. J.*, Vol. 24, Oct. 1938, pp. 31-34. Major industrial uses are in electroplating and photography; largest engineering uses are in Ag-solders and brazing alloys. Ag alloys are also used in automobile and airplane engine bearings, electrical contacts, welding rods and electrodes, and in Ag-clad metals for chemical equipment. Studies are now being made of the possibility of using Ag salts as fungicides and insecticides. In the metallurgical field, promising results have been obtained by addition of Ag to Mg-base alloys, bronze and Fe. BHS (10b)

Stressed-skin Airplanes of Aluminum Alloy. B. M. FOSTER. *J. Inst. Engrs., Australia,* Vol. 10, July 1938, pp. 263-272. Descriptive. The chief characteristic of the "stressed-skin" type of construction is that the fairing is built of this metal or other material and is made to perform the dual function of load-carrying structure and aerodynamic fairing. Some of the types of construction and some of the methods used in solving the problem of design are described. WHB (10b)

Investigation of Bearing Bronzes for Rolling Mills. N. A. FILIN. *Metallurg,* Vol. 13, Jan. 1938, pp. 105-111. In Russian. Original research. Six bronzes were investigated with a view toward utilizing them as anti-friction alloys. Best results were obtained with the following alloys: (1) 57 Cu, 37.5 Zn, 1.5 Al, 2.5 Mn, 1.5% Pb. (2) 54.7 Cu, 38.4 Zn, 2.9 Mn, 4% Pb. (3) 87 Cu, 9.5 Al, 3.5% Pb. These are less expensive than Sn-bronzes and their microstructure shows that they may be used under friction conditions. BZK (10b)

10c. Effect of Temperature

H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Light Metals for High Temperature Service. *Light Metals,* Vol. 1, Sept. 1938, p. 283. Review. Of Mg alloys intended for use at high temperatures, a Mg-Ce-Co-Mn alloy is recommended. This material contains 10% Ce and 1.5% each of Co and Mn. A short time tensile test at room temperature shows 37,000 lbs./in.^{2} ultimate strength, while at 300° C. the strength is lowered to no less than 14,800 lbs./in.^{2} A table of 14 Mg alloys is shown giving short time tensile results from room temperature to 300° C. It seems possible that, with more suitable heat treatments, some of these values could be improved upon. The creep rate for a given alloy depends, in large measure, upon its prior heat treatment. As service applications of light metals are usually short, the total strain during a creep test of short duration is often a better design criterion than the results of a long time test. The curve of limiting creep stress against temperature lies below the proportional limit-temperature curve at 300° C. and higher. It has been observed that softening and change of microstructure may occur during a creep test without altering the creep rate. This is at variance with established results on Fe and steel where changes in structure are accompanied by changes in creep rate. There is definite need for information on effect of prior aging on creep of age-hardenable Al alloys. Unlike steels, non-ferrous alloys do not show a definite stress value which may be described as a "fatigue limit." Mg alloys have, however, a more definite fatigue limit than Al alloys. In the latter there is no definite correlation between tensile strength and fatigue resistance. Age hardening has only a very slight effect on the endurance limit. Considerable data are included on the endurance limit of Al alloys after various treatments and at different temperatures. The endurance limit at 3 different temperatures of Electron (composition and heat treatment not given) is as follows: 15° C.—9,400 lbs./in.^{2}; 150° C.—5,700 lbs./in.^{2}; and 250° C—2,280 lbs./in.^{2} The elastic modulus of Al alloys falls off rapidly with temperature. Tapsell has found the modulus of duralumin to be as low as 2,500,000 lbs. at 350° C., compared to 10,000,000 lbs. at room temperature. Other workers have found a considerably smaller falling off with temperature. Structural permanence under low stressing, coupled with resistance to oxidation are requirements which Al alloys in general easily meet. But certain applications, such as aero-engines, require extraordinary combinations of properties, and selection centers about permanence of properties, short-time tensile data at elevated temperatures, as well as creep resistance, and fatigue properties. More and more data are constantly required as the complexity of service application grows. In regard to developing light metals for temperatures in excess of about 250° C., Be-rich alloys are a possibility, or recourse may be had to duplex materials in which the part subject to the highest temperature may not be a light metal. See also *Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 134 R 5. AUS (10c)

Giving CHROME STEELS greater resistance to heat

In certain industrial operations—such as oil refining—steel is subjected to a service involving an extraordinary combination of stress, high temperature and corrosion. Too severe for ordinary grades of plain carbon steel! Yet a 5% chromium addition to the steel more than paid for its cost, in terms of its unusual resistance to corrosion and to stress at high temperature.

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As a solution to this problem, a Titanium-treatment for chrome steels was developed which has effectively overcome the air-hardening tendency. Due to its strong affinity for carbon, Titanium practically removes all carbon from combination with chromium (preventing the formation of martensite on cooling) and thereby keeping the steel soft under all conditions.

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11 · CORROSION AND WEAR

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Corrosion Control—Studies and Operating Experiences. *J. Am. Water Works Assoc.*, Vol. 30, Aug. 1938, pp. 1342-1387. A series of brief papers as follows: **Engineering and Economic Aspects of Pipe Corrosion and Its Control.** THOMAS H. WIGGIN, pp. 1343-1352. Experiences recounted. Internal corrosion of pipes is very prevalent—almost universal—and the expense of good protection for metal pipes, such as cement-lining or tar enamel, is amply justified for metal pipes, while other less corrodible pipe, such as reinforced concrete or cement-asbestos, have also their place. Cleaning has its place, but one should be prepared for yearly re-cleaning if high coefficients are to be sustained. Lime treatment has proved of only limited value in the writer's experience in preserving flow coefficients. Degasification, as used by Powell and Burns, has been very successful in a closed system; how much exposure in open tanks will nullify its benefits remains to be demonstrated. **The Effectiveness of Chemical Treatment for the Control of Pipe Corrosion.** GEO. D. NORCUM, pp. 1353-1365. As the result of experiments which are still progressing, involving the routine inspection of pipe lines carrying water undergoing chemical treatment, the author offers the following generalizations: Corrosion can take place without the production of any red water and without any increase in the Fe content of the water in the distribution system. A coating can definitely be laid down in pipes by lime treatment. The coating spreads over the surface of old scale, but corrosion seems to be still going on within the tubercles. It could not be determined if the lime treatment was retarding the rate of tuberculation. Mains that have been mechanically cleaned corrode much more rapidly than those that have not been cleaned. **Calcium Carbonate Units and Corrosion Control.** I. M. GLACE. pp. 1375-1383. Excellent review with personal experience. **Correcting Corrosivity of Zeolite Softened Waters.** D. E. DAVIS, pp. 1375-1383. Data are reported from a number of communities on the use of the Langelier Saturation Index with zeolite softened waters. Ca and pH are the 2 factors exercising the greatest influence in affecting corrosion in zeolite treated waters. The ionic exchange of Ca for Na in zeolite softening tends to make the softened water more corrosive than the raw. This may be offset by increases in pH due to aeration (and loss of CO_2) or to direct absorption of H ions in the zeolite. **Experience with Zeolite Water Plant.** H. M. OLSON, p. 1384. The author's experience indicates that a zeolite system should be run undersaturated until scale in the piping system has been dissolved and then $CaCO_3$ correction made to protect the pipe. **Accomplishments with Chloramination.** J. WALTER ACKERMAN, p. 1385. Experience with Cl and ammonia treatment of 12 miles of 24 in. cast Fe pipe proved very satisfactory. **Use of Sodium Silicate in Corrosion Control at a Rayon Plant.** CARL ALEXANDER, pp. 1386-1387. Water should contain at least 50 to 60 p.p.m. silicates, calculated as silica, to form a protective film. At this plant, aluminum sulphate was used with lime and sodium carbonate as secondary treatment. Secondary treatment was replaced satisfactorily by sodium silicate. Sodium aluminate (which contained a certain percentage of silica) is now used. VVK (11)

Corrosion of Interior Parts of High-pressure Boiler Feed-pumps (Korrosion an Innenteilen bei Höchstdruck-Kesselspeisepumpen) G. WEYLAND. *Wärme*, Vol. 61, May 21, 1938, pp. 379-382. Original research. Shows in some 10 illustrations corroded parts of high pressure boiler feed pumps. Pressure, operating time and general description of construction material are given without correlating these data with the corrosion observed; however no corrosion effects were noticed in pumps feeding water of a pH value of 8 and higher, while severe corrosion attacks took place at pH = 6.4 and 6.5 under comparable working conditions. Tests were made by using 4 different materials in a pump. After 1500 hrs. service, the runners made of cast electric furnace steel containing 1.5% Mn were corroded, therefore, corrosion resistant material must be employed for all pump parts if pH is lower than 7. EF (11)

A Study on the Electrode Potentials of Metals and Alloys in Nitric Acid Solution. YOICHI YAMAMOTO. *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, Vol. 34, Sept. 1938, Abstract Suppl., pp. 34-35. English abstract. Original research. The single electrode potential of 21 pure metals, 2 non-metals (C and Si) and 6 alloys was determined in HNO_3 solutions of various concentration. A definite relation between the electrode potential determined 20 min. after immersion and the atomic number was established. No simple correlation between electrode potential and rate of attack was observed. The series of electrode potentials in fresh water and in HNO_3 solutions after 20 min. was as follows: (from lower to higher) *In fresh H_2O:* Mg → Zn → Mn → Cd → Pb → Fe → Si → Sn → high C-steel → Al → Sb → Ta → Co → Mo → Cr → 18/8 → 13% Cr stainless steel → 80/20 Ni-Cr → Ni → Bi → Monel metal → brass → Cu → Ag → W → Hg → C → Au → Pt. *In 5% HNO_3:* Mg → Mn → Zn → Cd → Pb → Al → Fe → Sn → Co → high C-steel → Ni → 13% Cr steel → Sb → 80/20 Ni-Cr → 18/8 → Bi → Monel metal → brass → Cu → W → Cr → Mo → Ta → Ag → Hg → Si → C → Au → Pt. *In 20% HNO_3:* Mg → Mn → Zn → Cd → Pb → Sn → Al → Fe → Ni → high C-steel → Co → 13% Cr steel → Bi → 80/20 Ni-Cr → 18/8 → Monel metal → brass → Cu → Sb → Ag → Mo → Ta → W → Hg → Au → Cr → Si → C → Pt. *In 40% HNO_3:* Mg → Mn → Cd → Zn → Sn → Pb → Ni → Al → Fe → high C-steel → Co → Bi → Monel metal → brass → Cu → Sb → Hg → 13% Cr steel → Ag → Mo → 80/20 Ni-Cr → 18/8 → W → Ta → Si → Cr → C → Au → Pt. *In 60% HNO_3:* Mg → Mn → Cd → Zn → Sn → Pb → Co → Bi → brass → Cu → Al → Sb → Ag → Hg → Monel metal → Ni → Mo → passive high C-steel → 80/20 Ni-Cr → 13% Cr steel → 18/8 → passive Fe → W → Ta → Cr → Si → C → Au → Pt. The experimental results are also given for 10%, 30% and 50% HNO_3 solutions. EF (11)

Influences of Many Factors on the Solubility of Copper-zinc Alloy in Acid. Part II. HARU KUGE. *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, Vol. 34, Apr. 1938, pp. 434-446. In English. Original research. The solubility of Cu, 90/10, 80/20 and 70/30 Cu-Zn in 1 *N* HNO_3 was studied in relation to grain size. The test pieces were suspended at the end of an agitator, rotating at 320 r.p.m. The mechanical and thermal treatments applied to obtain different grain sizes are described fully and the results presented in microstructures. *Copper:* The larger the grain, the greater the solution rate. No difference was found between a grain size of 60 μ^2 and 93 μ^2. The next size studied was 500 μ^2. *90/10 brass:* 4 grain sizes falling between 50 μ^2 and 150 μ^2 were studied. Solubility increases almost rectilinearly with grain size. *80/20 brass:* Grain sizes of 33, 177 and 225 μ^2 were obtained by 3 different heat treatments. At 40° C., solubility increases proportionally to grain size but at 50° C., only a general trend in this direction was found. *70/30 brass:* 5 different grain sizes between 33 μ^2 and 280 μ^2 were studied at 50° C. Up to 200 μ^2, the larger the grain, the greater the solubility. Between 200 μ^2 and 300 μ^2 hardly any increase of solubility was found. A maximum point in solubility may occur owing to the presence of 2 opposite effects: The larger the grain, the greater the e.m.f. and, consequently, the solubility. But the greater the boundary area, which means the smaller the grain, the stronger the galvanic action between the impurities at the grain boundaries and the adjacent metal. (For Part I, see *Metals and Alloys*, Vol. 9, Aug. 1938, p. MA 515 L/1). EF (11)

Corrosion-resistant Steels for Ammonia Synthesis. A. V. SMIRNOV. *Zhur. Khim. Prom.*, Vol. 15, No. 2, 1938, pp. 30-38. In Russian. For parts operating at 500° C. and 750 atm., a Cr-Mo steel (0.2% C, 6.0% Cr, 0.5% Mo) is recommended. An alloy of the "Amfi" type (60% Ni, 9% Cr, 3% W, 2% Mn) is resistant to all corrosion and heat conditions encountered in ammonia synthesis. N_2 is described as being at least as important as H_2 in its influence on corrosion. NA (11)

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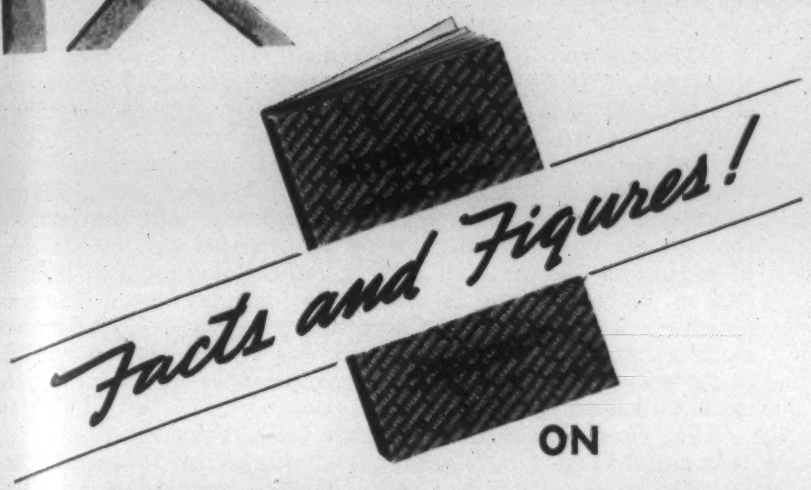

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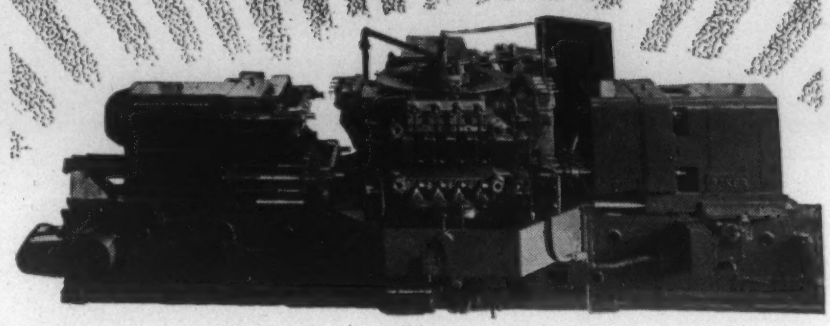

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12 · GENERAL

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

The Modern Method of Manufacturing Aluminum Powder. H. MEYERSBERG. *Aluminum & Non-Ferrous Rev.*, Vol. 3, Aug. 1938, pp. 299-302. Descriptive. The older process used Al lumps or Al foil as initial material. The lumps were produced by pouring Al on a water cooled fly-wheel; the foil had to be cut up. The powder was produced by stamping. The main disadvantage of this process is the danger of explosion during stamping and polishing operations. In the new process an inert gas, such as N, is used for protection. Flaky Al powder, required to have floating properties, should have an oxide film on the surface. Therefore, 1-3% O_2 is added to the protective gas; this percentage involves no explosion hazard. The modern way of disintegrating Al foil includes tearing up by hand, passing through magnetic separator and dissecting into small fragments in a saw box or similar machine. The final "flatting" is done in a drum that contains steel balls and a gear that lifts the balls up and drops them on the material during rotation. The number of balls usually used in ball mills does not yield the best results. The flake output increases with the number of balls, reaches a maximum, drops drastically, and reaches a second maximum 3 times as high as the first one. The amount of the steel balls corresponding to this second maximum of output is used for commercial production (patented in England). The drum itself is filled with the controlled atmosphere during the operation.
RPS (12)

History of the Steel Industry in the Chicago District. G. C. KIMBALL (Carnegie-Illinois Steel Corp.) *Blast Furnace Steel Plant*, Vol. 26, Sept. 1938, pp. 919-920, 940-941. The Fe and steel industry was founded in Chicago in 1857 with the establishment of North Chicago Rolling Mill Co. Other pioneering plants were: Union Rolling Mill Co., founded in 1863, and Union Coal, Iron & Transportation Co. at Joliet. All 3 manufactured Fe rails. In 1865, North Chicago Rolling Mill produced the first steel rails rolled in U. S. These were rolled from Bessemer ingots produced at Wyandotte, Mich. Bessemer converter was installed at North Chicago Rolling Mill shortly thereafter. Union Rolling Mill Co. built 2 blast furnaces in 1868 and a Bessemer plant in 1871. Joliet Works began operations in July, 1870, and completed a Bessemer plant in 1873. Present South Chicago plant of Carnegie-Illinois Steel Corp. was started in the early 1880's with 4 blast furnaces, a Bessemer plant and a mill for rolling heavy rails. Construction of Gary Works began in 1906. Present annual capacity of district is over 15,000,000 gross tons of ingots.
MS (12)

Recent Developments in the American Iron and Steel Industry. CLYDE E. WILLIAMS (Battelle Mem. Inst.) *J. Iron Steel Inst.*, Advance Copy No. 16, Oct. 1938, 22 pp. Up-to-date review. The subjects reviewed include blast-furnace raw materials, blast-furnace operation, pig Fe, Fe and steel scrap, residual metals in scrap, open-hearth operation, Bessemer and free-machining steels, grain-size control, pit practice, mill practice, steel sheets and strip, metallic coatings, enamelling sheet, surface treatment and priming coats, sheet for atmospheric corrosion resistance, low-alloy high-strength steel, alloy steel for heat treatment, special-purpose steels and stainless steels.
JLG (12)

The Sintering of Hard-metal Alloys. W. D. JONES. *Metallurgist (Suppl. Engineer)* Oct. 1938, pp. 171-175. Extended and critical review of paper by Meyer & Eilender in *Archiv. Eisenhüttenwesen.* See *Metals and Alloys*, Vol. 9, Oct. 1938, p. MA 625 R/6.
VVK (12)

"TRENDS" . . .

a new department on page MA126, interprets today's news in the light of probable future developments. This will be a regular monthly feature. You will want to read it.

Developments in the Manufacture of Metal Powders. J. C. CHASTON. *Metal Treatment*, Vol. 4, Summer 1938, pp. 49-52. Review. Al paint powders are now being produced in special ball mills in which an impact action is produced either by the use of internal shelves (in the Hametag process) or by careful adjustment of mill speed and charge (in the Hall process). In the Hametag process, the material is removed from the mill and conveyed through the polishing machine by an inert gas that avoids danger of explosion. In the Hall process, milling is performed in a solution of stearic acid and Al stearate in light oil, and no subsequent polishing is necessary. Spherical shaped Pb powder for paints is made by attrition in a slow-running ball mill. Reference is made to the hydride process and some miscellaneous methods of making metal powders. 11 references.
JCC (12)

Alloy Steel Designed for Specific Uses. VINCENT T. MALCOLM (Chapman Valve Co.) *Foundry*, Vol. 66, July 8, 1938, pp. 32, 33, 80, 83; Aug. 1938, pp. 28-29, 76, 78; Sept. 1938, pp. 30-31, 65-67. Practical. Divides special steels into those having high strength and toughness; those that resist wear, creep or elevated temperatures; those for welding; those that resist corrosion and oxidation; and free machining and non-seizing steels. Outlines briefly the functions of Cr, Ni, Mo, V, W, Ti, Co, Ni and Zr in various types of steels. Considers also variables met with and casting losses. Includes tables giving chemical composition of series of steels and their heat treatment. The 2nd instalment gives proper method of procedure to avert defects in castings. The final instalment describes the proper method of heat treating.
VSP (12)

Construction and Manufacture of Forged Iron Cannons for Firing Stone Balls in the Middle Ages (Aufbau und Herstellung der Schmiedeeisernen Steinbüchsen des Mittelalters) K. RITTER. *Tech. Mitt. Krupp, Tech. Ber.*, Vol. 6, Sept. 1938, pp. 113-127. A history of the cannons for firing big stone balls is given; they were built first in the middle of the 14th century and disappeared in the 16th. The Fe or steel used for them can be compared with a modern mild steel of 0.05% C, and had a tensile strength of 45,500 lbs./in.^{2}, elastic limit of 31,000 lbs./in.^{2} and an elongation of 35%. The manufacture in different countries is interestingly described. The cannon in some cases were capable of firing stone balls up to 200 lbs. An atlas of 11 tables illustrates technically interesting pieces. 13 references.
Ha (12)

National and International Importance of Some Problems of German Metallurgy (Einige Aufgaben der deutschen Metallurgie, ihre nationale und internationale Bedeutung) E. HOUDREMONT. *Stahl u. Eisen*, Vol. 58, Nov. 3, 1938, pp. 1185-1199. General. Some of the metallurgical problems that Germany has attacked in furtherance of its 4-year plan, and to utilize low grade domestic raw materials wherever possible, are also of interest to other countries. Among these are: Smelting pig Fe with a more acid slag, and desulphurizing later with Na_2CO_3, thus making use of low Fe high SiO_2 ores; ore concentration; recovery of Mn and V; substitution of cheaper alloying elements and use of clad metals.
SE (12)

Scanning the Year's Progress in Metals, Their Treatment and Fabrication. *Steel*, Vol. 103, Oct. 10, 1938, pp. 126-128, 130, 137-138, 140, 143, 146, 148, 150-152, 154, 156, 158-159, 162, 164. Comprehensive review. Consists of a number of short articles, each written by an authority, on various phases of metallurgical development. Both ferrous and non-ferrous metals and alloys are discussed.
MS (12)

Powder Metallurgy. G. J. COMSTOCK.. *Mech. Eng.*, Vol. 60, Nov. 1938, pp. 801-806. An account is given of the increasing importance to industry of the fabrication of objects from metal powders, and the development of methods of manufacturing metal powders is briefly described. Four principal commercial products are at present being made by powder metallurgy: (1) The refractory metals W, Mo and Ta, (2) electrical contact and electrode materials, (3) porous bearings, and (4) hard cemented carbides for tool and die materials. The manufacturing methods, equipment used for them and a variety of examples are described. 18 references.
Ha (12)

books

Metal Coloring and Finishing

Hugo Krause

Chemical Publishing Co. of N. Y., New York, 1938. Cloth, 6¼ x 9¼ in., 222 pages. Price $5.00.

For some time there has been need for a comprehensive reference text in the field of chemical metal coloring and corrosion protection. This need was partially fulfilled with the advent of the new edition of Krause's book in 1937. Unfortunately it was in German and thus not available to many American and English readers. The present translation by an anonymous author, however, is a disappointment and in no way lives up to the original work. It is full of errors and appears to have been very carelessly done and proof read. For example, one glaring error which occurs repeatedly is the translation of *Salzsäure,* the German word for hydrochloric or muriatic acid, by *nitric acid.* The translator's apparent unfamiliarity with common terms of the art leads to the translation of the German verbs *beizen, dekapieren, brennen,* etc., all meaning to pickle a metal, by such obviously misfit, and even misleading, words as to *stain, to burn, to peel,* and even *to anneal.* The last mentioned gem occurs in a number of instances. Such well-known processes as the Bullard-Dunn electrolytic pickling process, correctly described in the original, are not so in the translation. Much of the descriptive matter is so confused in the translation as to be useless.

All of the book, of course, is not bad. Many sections are well translated. But in order to know which information is correct and which is not the reader would have to have a copy of the German edition at his elbow.—IVER IGELSRUD.

Handbook of Brinell, Rockwell and Vickers Hardness Testing *(Der Kugeldruckversuch nach Brinell, die Härteprüfung mit Vorlast und die Härteprüfung nach Vickers—ein Handbuch)*

Georg Reicherter

Julius Springer Verlag, Berlin, 1938. Paper, 6¼ x 9 in., 200 pages. Price RM 4.50.

This book isn't at all what its title makes it out to be. It is a combined catalog and instruction book for using a dozen types of hardness testers made by Reicherter. The usual precautions for obtaining accurate readings are given and the usual conversion tables appended.

It should obviously be given free to any purchaser of one of the machines listed and is equally obviously not worth its price on a hand book basis.—H. W. GILLETT.

Blast Furnace Practice

Ralph H. Sweetser

McGraw-Hill Book Co., New York, 1938. Cloth, 6½ x 9¼ in., 356 pages. Price $4.00.

Since the books of J. E. Johnson, Jr., were published, some twenty years ago, blast furnace design and operation has been written up only in articles on specific matters. Much work by Joseph and his associates has been published by the Bureau of Mines in scattered form. Only those intimately connected with the blast furnace, who have assimilated such publications as they came out, have a connected picture of the whole field.

Sweetser gives such a picture, as seen through the eyes of an experienced blast furnace superintendent, who strives to turn to account in actual practice, every new fact and new thought brought out by research, and whose practical experience lets him winnow the wheat from the chaff.

Everything a blast furnace superintendent might be concerned with gets more or less comment in the volume. The chapters cover the design, construction and repair of the furnace and auxiliary equipment, raw materials, theory and chemistry of the process, operating the process, by-products of the blast furnace, and the commercial, economic and accounting side. The writing is in a reminiscent vein throughout, with side comments culled from the author's own experience. Sweetser usually has pretty definite opinions on most moot points and doesn't hesitate to state them. The blast furnace man's jargon is freely used, usually with explanations of the terms. One peculiar phraseology is in referring to molten iron as it goes to the open-hearth in the hot metal process, as having "combined carbon."

The personal touch of Sweetser's style would carry conviction to any reader (even if he did not know Sweetser, as blast furnace men all do) that the author is writing from long experience. Few technical books are written as authoritatively as this; most authors deal with subjects so wide that much of the contents of their books are necessarily second-hand. Sweetser, on the contrary, has had close contact with everything discussed. Many quotations are given from others, but only because they express what he also believes on first-hand evidence.

Blast furnace men will not be able to get along without adding the book to their library, and metallurgical engineers in general will want it because it gives a readable, coherent picture of a branch of the industry whose literature has hitherto been scanty.—H. W. GILLETT.

Twenty-third Annual Review of the Silver Market

Handy & Harman, New York, 1938. Cloth, 5 x 7 in., 30 pages.

This volume is devoted chiefly to appraisal of the U. S. Government's silver-buying policy. It is estimated that this has cost over a billion dollars, 82% of which went to foreign producers, and has resulted in a decreased use of silver throughout the world. As a Bombay correspondent puts it: "India is slowly losing the fascination she has had for silver for centuries and is turning to other types of investment. With China in the hands of the Japanese, the U. S. Treasury will be the only admirer of silver."

The economics of the case indicate that so much damage is being done the country by the hand-out to silver producers that the ultimate repeal of the Silver Purchase Act of 1934 is considered probable.

Owing to general business shrinkage, total consumption of silver by arts and industries in the U. S. and Canada in 1938 showed a 13% drop from the previous year. Motion pictures and silver-plated ware each only used 5% less, jewelry and sterling silverware lost 15%. The dental trade also used less silver. Purely industrial use showed a 35% decline. Use of silver in electrical and chemical trades in England is on the increase. Basic conditions indicate a continued growth of industrial uses in the U. S.—H. W. GILLETT.

Forging Practice

C. G. Johnson

American Technical Society, Chicago, 1938. Cloth, 5¾ x 8½ in., 136 pages. Price $1.50.

The series of books of which this little volume is a typical unit represents an interesting and useful publishing innovation. Simple, elementary, authoritatively written, and inexpensive, each book is evidently intended for non-experts of various classes: Trade school and technical high school students, metallurgical engineering students in their early college years, and in general anyone in industry who needs to know how certain things are done, without necessarily having to do them.

We particularly recommend this and similar books to young men just out of college, and just starting out on a metallurgical career, whose academic training has probably ignored many of the practical points discussed by the author, a professor in mechanical engineering at Worcester Polytechnic Institute. Industry expects the metallurgical engineer to have a somewhat broader knowledge of his subject than he can get in the present-day courses in "metallurgy." He will be impelled not only to learn as early as possible what happens to the structure and properties of metals when they are worked, heated, cooled, joined, etc., but also to be familiar with the engineering equipment available for performing these operations. Books like this therefore fulfill a real need in making such information available in brief and generally accurate form.

The treatment is extremely practical and covers not only "forging" as it is ordinarily understood, but hot and cold rolling, roll piercing, cold swaging, pressing, drawing and spinning, and extrusion. Equipment, methods, metallurgical effects and auxiliary operations, such as heating and heat treatment, are discussed for each process.

Of course, as one would expect in any book of this size, the treatment cannot be very intensive, but it does cover adequately the general field of plastic working in useful, understandable fashion.—FRED P. PETERS.

The Mineral Industry During 1937

G. A. Roush

McGraw-Hill Book Co., Inc., New York, 1938. Cloth, 6½ x 9½ in., 778 pages. Price $12.00.

This volume appears each year and this one supplements the 45 previous issues. As in the past, it brings up-to-date statistical and general information on the industry in this and other countries. There is also included some general technological and trade information. In this volume there are 33 contributors who are generally recognized as authorities in their respective fields. Much of the principal minerals and metals are discussed and much valuable general information is offered. The sections on Foreign Coins, the State Geological Surveys, the Trade Associations of the United States, the Professional Organizations of the United States and Canada, the Current Tariff Rates on Mineral and Metal Products and Weight Conversion Factors will be referred to by many.

The introduction to this volume calls attention to the fact that the editor completes his 25th volume with this issue. Because of this he has thought, and rightly so, that the time is opportune to present a brief summary of developments during these 25 years. This is contained in a special section—"The Mineral Industry, 1913 to 1937." In it will be found considerable data and comments of interest.

A change in the method of indexing has been inaugurated and it is a good one. A detailed index of the contents of each section is placed at the beginning of each one so that the reader will have this more readily available for reference and guidance instead of being obliged to hunt through a general index.—EDWIN F. CONE.

Stephen Timoshenko—60th Anniversary Volume

Macmillan Co., New York, 1938. Cloth, 6¼ x 9½ in., 277 pages. Price $5.00.

This collection of 30 separate papers, by as many students or associates of Timoshenko, on the occasion of his 60th birthday, is a type of appreciation of a great teacher and scientist that is common abroad, rare in this country. The individual authors hail from Canada, England, Germany, Holland, Poland, Turkey, and the U. S.; Cambridge, California, Cal. Tech., Columbia, Harvard, M.I.T., Michigan, Oxford, Stanford, and Yale Universities; from the Goodyear-Zeppelin, Timken, and Westinghouse industrial organizations, and a few other scientific groups. Authors with strictly English names are much in the minority, and most of those are from England and Canada; the American authors, with a few exceptions, have foreign names. One wonders whether foreign training or ability inherited from foreign-trained ancestors, is required before an American has the proper background to grasp the type of mechanics which Timoshenko has been a pioneer in developing.

When a metallurgical engineer is forced to deal with problems in design that require difficult and special mechanics, he finds Timoshenko's books and articles not only sound and authoritative, but as clear and understandable as it is in the nature of such things to be. Some of his students and associates who wrote these 30 articles have learned something of his clarity, some might take a few more lessons.

The majority of the articles are straight mechanics that do not directly touch metallurgical engineering, but enough of them deal with questions of stress concentration, fatigue, wear and creep to make the volume of interest to metallurgists and engineers concerned with these problems. Articles in this class are by Ellis, on forgeability of copper, Horger on axle fatigue, Karelitz on dry friction, MacGregor on true stress in the tensile test, Nadai on mathematics of creep, Peterson on stress concentration in fatigue, Prandtl on plastic flow and elastic after-effect, Soderberg on creep, Taylor on plastic strain, Waters on relaxation and Weibel on photoelasticity. Most of the data and points of view of these authors have been previously published elsewhere, but space limitations have forced them to boil it down so that these articles are often more usable than the longer originals.

The volume is a deserved tribute and its contents have value. Its preparation was in the hands of a committee headed by Prof. J. M. Lessells, who also wrote the interesting introductory account of Timoshenko's career.—H. W. GILLETT.

German Grammar for Chemists and Other Science Students

John T. Fotos and John L. Bray

John Wiley & Sons, Inc., New York, 1938. Cloth, 5¾ x 8¼ in., 323 pages. Price $2.25.

This book was prepared primarily for the student of science and technology who is interested in acquiring a reading knowledge of German books and periodicals. With the increasing pressure of other subjects, students of chemistry and metallurgy cannot afford two or three years to obtain a reading knowledge of technical German, a necessity for the chemist, metallurgist or metallurgical engineer who wishes to keep in touch with developments.

Some years ago, the reviewer offered a course in Metallurgical German at the Carnegie Institute of Technology, and later at Columbia, without prerequisites. This book would have been very effective if available at that time.

The book will prove valuable to those who must acquire a reading knowledge of technical German, but will also prove of value to those who feel they already have acquired this reading knowledge.—RICHARD RIMBACH.

CURRENT news

Revere's New Mill

Revere Copper & Brass Inc., has announced completion of a $3,250,000 brass and copper mill at Rome, N. Y., as part of a huge modernization program. In making the announcement, C. Donald Dallas, president, declared, "This new mill is the culmination of a plant improvement program started several years ago. In the past 5 yrs. several million dollars in addition to this has been expended in Revere plants at Rome, Chicago, Detroit, Baltimore and New Bedford, Mass." The Revere executive pointed out that much of the modernization program was carried out during a period of depressed business. "Heavy industry," he said, "cannot modernize during a period of great business activity. The idea that heavy industry must stop all capital outlay and accept plant depreciation and equipment obsolescence in dull times is all wrong."

Revere's new mill at Rome incorporates the latest innovations in straight-line production in the copper and brass industry. The mill has a monthly capacity of 2,000,000 lbs. of brass strip up to 20 in. in width and its compactness is indicated by the fact that this capacity is contained within a floor area of 72,000 sq. ft. which is believed to be the lowest ratio in the industry. Innovations include a new escalator conveyor system whereby the brass slabs are automatically fed and re-fed into the breakdown mill, each sequence being controlled by a series of electric eyes.

The new brass mill is adjacent to Revere's copper rolling mill in Rome, N. Y., built in 1929, and having a monthly capacity of 10,000,000 lbs. of sheets and strip up to 48 in. in width. This installation includes 4 stands of 4-high rolls operated in tandem and thus is claimed to be the largest continuous mill in the industry.

Electroplaters' 1939 Convention

The Newark Branch of the American Electro-Platers Society, which has been awarded the annual convention for 1939, is to make this convention the largest and best ever held by this society. The convention will be an international affair and will be held at Asbury Park, on June 19 to 22.

By making this convention an international one and also because it is only about an hour from New York City, twofold benefits will be derived. The location at Asbury Park will make it convenient to attend the New York World's Fair which many will want to visit.

N.C.E. Gives Metallurgy Course

The Newark College of Engineering announces a special evening course in physical metallurgy and heat treatment, which started Friday, Jan. 13, 1939. The course is given for men actively engaged in the metal industries (preferably with preparation in college physics and chemistry, or its equivalent), and consists of a series of lectures and laboratory work. Lectures cover the manufacture of iron and steel, a detailed discussion of binary and ternary alloys and the effect of alloying constituents on steel. Laboratory work includes the microscopic examination of 15 to 20 metals, carburizing practice, use of the dilatometer, calibration of a thermocouple, and an intensive study of the effect of thermal treatment on carbon steels and non-ferrous alloys.

The laboratory is equipped with polishing equipment, hand microscopes, and two metallographic outfits. The furnace equipment includes both gas and electric furnaces, some of which are automatically controlled as to temperature. Both millivoltmeter and potentiometer type pyrometers are available.

The course is scheduled for 6 hrs. a week for 15 weeks on Wednesday and Friday evenings, 6:30 to 9:30. For further information, readers may address the registrar, Newark College of Engineering, 367 High St., Newark, N. J.

Youngstown To Make Leaded Steels

Lead-bearing steel will be produced by the Youngstown Sheet & Tube Co., licensed under the Ledloy patents of the Inland Steel Co. The use of lead-bearing steel for all kinds of machining operations has spread with amazing rapidity, Ledloy sales records show. Conservative examples of the faster machining speeds permitted vary from 30 per cent to more than 100 per cent, with tool life increased from 200 to 300 per cent.

The addition of lead by the Inland process has no measurable effect upon the physical or heat treating qualities of steel in any analysis, except perhaps for slight grain refinement, it is stated. It is interesting to note that Ledloy is but 0.04 per cent heavier than standard steels. This would amount to the volume of 3 cu. in. per ton of steel. Recent tests also show that lead-bearing steels may be coated or plated by the dipping or electroplating process in the same way and with the same results as regular steel.

International Acetylene Association to Meet In Houston

The 39th Convention of the International Acetylene Association is to be held in Houston, Texas, on March 8 to 10, 1939. Headquarters will be at the Rice Hotel.

In announcing the unanimous decision of the officers and directors, the secretary of the association referred to the splendid convention of the association in Birmingham last year—the first in the South—also to the increasingly numerous requests and invitations that have been received by the association during recent years to visit the great Southwest.

An interesting technical program, covering the most important developments in the application of the oxy-acetylene process of welding and cutting is in preparation.

Erratum

In an article—A French Appraisal of Rimmed vs. Killed Steels—in our December, 1938, issue, there is an error in the caption of the illustration on page 348. The composition of the split ingot should read 0.20 per cent carbon and not 0.020 per cent.

(Continued on page MA 125)

Advertisers' Index

Air Reduction Sales Company ..... MA 101
Ajax Electric Company, Inc. ..... Outside Back Cover
Ajax Electric Furnace Corporation .... Outside Back Cover
Ajax Electrothermic Corporation MA 87; Outside Back Cover
Ajax Metal Company ..... Outside Back Cover
Alan Wood Steel Company ..... A 17
Allegheny Ludlum Steel Corporation ..... MA 115
Aluminum Company of America ..... MA 78, MA 79
American Bridge Company ..... MA 87
American Car and Foundry Company ..... MA 98
American Chain & Cable Company, Inc., Page Steel & Wire Division ..... MA 103
American Chemical Paint Company ..... A 21
American Cyanamid & Chemical Corporation ..... A 16
American Electric Furnace Company ..... MA 92
American Gas Association ..... MA 89
American Gas Furnace Company ..... MA 93
American Machine & Metals, Inc., Riehle Testing Machine Division ..... MA 109
Ampco Metal, Inc. ..... MA 119
Armstrong Cork Company ..... MA 75

Babcock & Wilcox Company ..... Inside Front Cover
Brown Instrument Company ..... A 22
Buehler, Adolph I. ..... MA 111

Calorizing Company ..... MA 97
Carborundum Company, Refractory Division Inside Back Cover
Carnegie-Illinois Steel Corporation ..... A 2, A 3
Chicago Flexible Shaft Company ..... MA 96
Climax Molybdenum Company Insert between page 66 and MA 71
Columbia Steel Company ..... A 2, A 3, MA 87

De Witt Operated Hotels ..... MA 112
Dietert Company, Harry W. ..... MA 109
Driver Company, Wilbur B. ..... MA 95
du Pont de Nemours & Company, Incorporated, E. I., R. & H. Chemicals Department ..... MA 99

Electric Furnace Company ..... MA 95
Electro Alloys Company ..... MA 80
Electro Metallurgical Company ..... A 5

Foxboro Company ..... A 13

Gaertner Scientific Corporation ..... A 21
General Electric Company ..... A 14

Halsall & Company, Daniel ..... MA 86
Handy & Harman ..... MA 102
Hilger Ltd., Adam ..... MA 108
Hotel Adelphia ..... MA 116

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Ingersoll-Rand Company ..... A 15
International Nickel Company, Inc. ..... A 24, MA 77

Jarrell-Ash Company ..... MA 108
Johns-Manville Corporation ..... A 9, MA 93
Jones & Laughlin Steel Corporation ..... MA 72, MA 73

Leeds & Northrup Company Insert between page A 4 & A 5
Leitz, Inc., E. ..... MA 113
Lewis Engineering Company ..... MA 96, MA 106

Mathieson Alkali Works, Inc. ..... MA 85
Minneapolis-Honeywell Regulator Company ..... A 22

New Jersey Zinc Co. ..... A 26
Nitralloy Corporation ..... MA 119
Norton Company ..... A 19

Page Steel & Wire Division, American Chain & Cable Company, Inc. ..... MA 103
Pittsburgh Lectrodryer Corporation ..... MA 98

Republic Steel Corporation ..... A 10, A 11
Riehle Testing Machine Division, American Machine & Metals, Inc. ..... MA 109
Ryerson & Son, Inc., Joseph T. ..... MA 94

St. Joseph Lead Company ..... MA 76
Scherr Company, George ..... MA 113
Scomet Engineering Company ..... MA 116
Scott Company, Henry L. ..... MA 106
Spencer Turbine Company ..... MA 91

Taylor Sons Company, Charles ..... A 12
Thermal Syndicate, Ltd. ..... MA 94
Timken Roller Bearing Company Steel & Tube Division ..... A 4
Titanium Alloy Manufacturing Company ..... MA 117

Union Carbide and Carbon Corporation ..... A 5
United States Steel Corporation ..... A 2, A 3, MA 87
United States Steel Products Company .. A 2, A 3, MA 87

Wilson Mechanical Instrument Company, Inc. ... MA 109

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Navy to X-ray Vital Parts of Fleet

The United States Navy has turned to one of science's newest and most powerful life-savers—X-rays—for use in the New York and Philadelphia Navy Yards.

Capable of detecting all-important defects in metals up to 3 in. thick, the new units are expected to pick out flaws not only invisible to the unaided eye, but indistinguishable in the finished radiographs to all but experts specially trained to "read" them. Once spotted, the defective areas will be automatically replaced, with a consequent probable saving of life and limb on the high seas. In the air the safety factor is even more vital.

The new Westinghouse unit is designed to prevent such accidents by inspecting vital members before ships leave the airports or the ways. An important feature of the new unit is that, although it weighs three-quarters of a ton, it can be loaded aboard ship and moved about easily on its balloon tires. It is approximately 3 ft. wide by 5 ft. long over all, with a 10-ft. tube-stand. Yet so delicately balanced are its counterweights that the tube-head can be manipulated with ease.

Research on Chilled Car Wheels

The Association of Manufacturers of Chilled Car Wheels has established a research project at Battelle Memorial Institute on chilled irons for use in car wheels, according to an announcement by F. H. Hardin, president of the association, and Clyde E. Williams, director of Battelle Memorial Institute. The work will comprise a critical study of the material in current use and of new compositions in the iron-carbon group of metals.

International Foundry Congress 1939

Planned by the Institute of British Foundrymen, under the auspices of the International Committee of Foundry Technical Associations, the next International Foundry Congress will be held in London from June 12 to 17, and will be followed by a tour of the principal foundry centres of Great Britain from June 18 to 24 and from June 25 to 30. The President of the Congress will be W. B. Lake, J. P., president of the Institute of British Foundrymen for 1939-40, and one of England's pioneers in the electric furnace steel foundry industry. A number of prominent industrialists and scientists have consented to give their patronage to the Congress, the secretary of which will be T. Makemson, secretary of the Institute of British Foundrymen.

Inland Lights a New Blast Furnace

Inland has just completed, and lighted, its fifth blast furnace. This is a new 1,000 ton per day furnace of the very latest type.

An interesting program and ceremony was carried out. It has been 12 yrs. since the last Inland furnace was built.

● James H. Critchett and Francis B. Morgan have been elected vice-presidents of Electro Metallurgical Co., a unit of Union Carbide and Carbon Corp., New York. Dr. Critchett has been in charge of research work, and Mr. Morgan has been works manager for this company.

● Dr. F. R. Morral, formerly a professor at Purdue University, has become associated with the Continental Steel Corp., Kokomo, Ind.

● John F. Baker, formerly with Surface Combustion Co., is now representing the Ajax Electric Co., Inc., in the Pittsburgh district.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 West 42nd Street, New York.*

POSITION WANTED: Welding technician, with ten years' experience in research, development and supervision in the field of Shielded Arc—(Hand and Automatic) Gas and Resistance Welding. Thoroughly trained in "Welding Metallurgy." Broad knowledge of metals and methods of welding and testing. Capable of supervising all features pertaining to code welding, including X-ray work. Age 34. Married. Box MA-118.

POSITION WANTED: Executive, sales promotion experience, engineering background, analyst, statistician, 14 years' experience large manufacturer welding supplies, played leading part in organizing field service personnel, age 46, married, steady worker. Box MA-119.

POSITION WANTED: New England Representative. Metallurgical engineer desires connection with supplier or manufacturer of chemicals, minerals, metals or equipment, who is interested in personal representation in this area to the industrial and jobbing trade. Box MA-120.

POSITION WANTED: Foundry Metallurgist, age 26, single, 2½ years' gray iron foundry metallurgist. Two years as chemical analyst, ferrous metals. Technical training with practical experience. Available immediately. Box MA-121.

A LARGE firm of manufacturers wishes to purchase a patented or proprietary article, involving the use of aluminium or magnesium castings in large quantities.

Please submit details to Box No. 6, c/o Metals and Alloys, 330 West 42nd St., New York, N. Y.

trends

by Edwin F. Cone, Editor

Banks and Research

Recently we had a questionnaire from the vice president of a large bank in the east asking "what important developments will assert themselves in your field as a result of research in the next three years?" The information was desired as the basis of a general article on "new things coming along in various industries to fan bankers' interest in research and develop research mindedness in their dealings with industry." This is a laudable undertaking. It indicates a trend in the right direction—a better understanding by financial interests of the soundness of investments in research laboratories and their achievements.

Controlled Atmospheres

We are impressed with the fact that, as we contact various individuals close to the situation, there is a strong tendency for controlled atmospheres, hitherto applied largely to the annealing and normalizing of sheet and strip, to be improved so as to be applicable to heating or quenching in heat treatment which will avoid pickling losses or the necessity of machining off a decarburized skin and the combination of controlled atmosphere heating with a skin gas carburizing action. Progress in the application of controlled atmospheres is rapid and our visits to various heat-treating departments bring out the fact that furnaces with such atmospheres are more and more being used.

Sponge Iron

Imports of sponge iron have expanded rapidly in recent years. In 1931 they were only 17½ gross tons per month but in 1936 and 1937 the average was between 156 and 162½ tons each month—all from Sweden. The 1938 volume has been less due to the "recession" in business. A considerable portion of this is used in powder metallurgy—largely for bearings—according to Gregory Comstock.

Bearings of Ag-Base Metal

Silver-base bearing metals are on the way. In some of the present-day large aircraft engines, the shortcomings of bearing materials have been realized. It is believed that the silver-base alloys will meet the more drastic requirements. This situation was discussed in an article in our December, 1938, issue by R. W. Dayton. Further elaboration will be available in a paper by the same authority before the mining engineers' convention this month.

Die Castings

We had the pleasure recently of hearing an instructive and comprehensive address by Charles Pack, vice president of the Doehler Die Casting Co., on "Die Castings." In reply to a question as to whether the heat treatable or age-hardening aluminum alloys are being die cast, he replied that they are being successfully made and used in the as-cast condition but are not being heat-treated. The present alloys do not lend themselves to such treatment, partly because of distortion. Mr. Pack believes that alloys of this character will be developed which can be die cast and heat treated.

German Electric Steel

That the trend in the production of electric steel in Germany is decidedly upward is revealed by a study of German statistics. For 1937, the latest official data, the electric and crucible (mostly electric) output was over 700,300 metric tons, an increase of 40.5 per cent over the 1936 total and by far the largest on record. This trend is particularly true since 1934. In comparison the same American production was 846,471 gross tons in 1937, an increase of only 9.5 per cent over 1936. In 1937 the German electric steel output was about 3.5 per cent of the country's total; the American was 2.37 per cent. If the present trend continues, Germany may surpass us in electric furnace steel.

Basic Open-Hearth Steel

A tendency in recent years which has gained momentum is the greater use of basic open-hearth steel. This grade is now being used for products which only a few years ago were considered poor in quality unless made of acid open-hearth. There have been marked improvements made in the processing and control of basic furnaces so that basic steel is regarded by many as good as acid. We know of one large plant which formerly made all of its steel in acid furnaces—at present most of these are basic and the product is of as high, if not higher, grade than ever.

More About Basic O.-H.

Statistical evidence of the trend to basic open-hearth steel is furnished by a study of data of the American Iron and Steel Institute. In 1917, of the total open-hearth steel ingot output, 95.73 per cent was basic; in 1923, this was 98.12 per cent. Four years later (1927) 98.67 per cent of the total was basic and 10 years later this proportion had increased to 99.27 per cent. In capacity calculations also, the data are similar. In 1917, basic open-hearth capacity was 93.96 per cent of total ingot. By 1937, or 20 years later, this had increased to 98.92 per cent. If this trend continues, the quantity of acid open-hearth ingot steel will soon have almost disappeared.

Foreign Ferromanganese

Because of competition from foreign producers of blast furnace ferromanganese, American makers were obliged in January to reduce their quotations from $92.50, seaboard, to $80 per gross ton of 80 per cent alloy. The principal sources of the foreign supply have been Holland, Czechoslovakia and Dalmatia. Some of this product has been made from "distress" supplies of manganese ore. This trend is pointed to as one result of the conditions in Germany from which country metal men have been forced into other fields of activity.

New Equipment and Materials

The FerroTemp Pyrometer

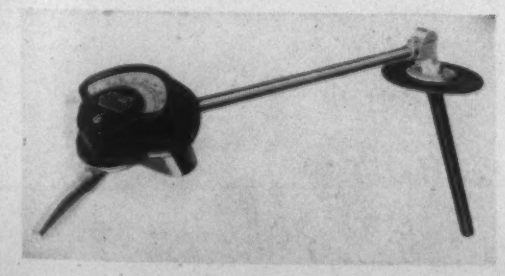
The Harry W. Dietert Co., Detroit, announces the "FerroTemp" which is a pyrometer unit for measuring accurately the temperature of molten grey and white iron by means of an immersion thermocouple. The thermocouple of the FerroTemp is 1⅛ in. outside diameter and 19 in. in length. The depth of immersing the thermocouple into the molten metal does not affect the accuracy of temperature readings. The life of the economically priced thermocouple is better than 100 immersions. Every thermocouple receives a stabilizing treatment insuring accuracy for life of the couple. The iron and slag will not adhere to the thermocouple. The FerroTemp comes to the maximum temperature 15 seconds after immersing the thermocouple in the molten metal.

The FerroTemp is available in two models. A portable type as illustrated and a stationary type, similar to the portable model with the exception that a flexible extension lead connects the FerroTemp to a wall type pyrometer with a large dial which may be read at a 50-ft. distance.

The FerroTemp of the portable model is equipped with a sturdy meter having non-breakable crystal covering the bold type temperature scale which is 6 in. in length. The temperature scale reads from 1600 to 3200 deg. F. The smallest temperature division on the scale is 20 deg. allowing easy estimation to 10 deg. at a glance. The weight of the portable model FerroTemp is 8 lbs. The overall length is 47 in.

The stationary model of the FerroTemp is designed to operate at a fixed location in the plant. It has the advantage of working in conjunction with a large pyrometer which records the temperatures.

Either model of FerroTempt unit is independent of the human error and may be used as a control instrument to measure the temperature of the molten metal as it comes from the furnace or cupola. It may also be used to a great advantage to determine when a ladle of molten metal cools to a definite temperature as found most suitable for pouring a certain type of casting. For the intricately designed castings, practice has shown that, when the metal is poured at a temperature within 20 deg. of the ideal, defects are at a minimum.



Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts no more than 2 in. wide.

A practice of measuring and recording molten iron temperatures from furnace or cupola every half hour has given information making it possible to adjust operating procedure to eliminate metal of undesirable temperatures.

Automatic Degreasing Machine

An automatic solvent degreasing machine designated as "Auto-Solv", has been placed on the market by the Mechanical Process Corp., South Orange, N. J. It is especially suited to cleaning small parts automatically. This is claimed to be made possible by a patented perforated scroll-type bucket.

The parts to be cleaned are deposited from the tote pan onto the loading table and, as the bucket passes a valve under the table, a measured quantity of material is dropped into it. The buckets are carried on a chain conveyor into the machine and through the lower tray of boiling hot solvent. Here they are rotated slowly in the liquid, gently separating the parts, and as a bucket leaves this bath, it passes through a shower of pure solvent and into another tray directly above the first. Again the bucket is rotated in this pure solvent where the parts are thoroughly rinsed. On leaving this tray, it is rotated slowly again where the excess solvent is drained and the parts are dried. When the container reaches the hopper, the bucket receives a rotation in the opposite direction, dumping the parts automatically into a waiting receptacle. An automatic control prevents mixing batches of parts.

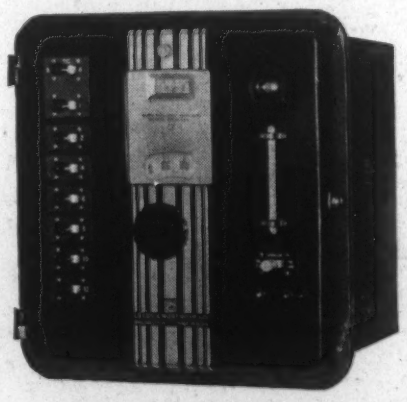
The solvent used is D'Oilene "A" or D'Oilene "B", and provisions are made within the machine to constantly distill the dirty liquid and automatically separate the grease and oil from it, in order to provide a constant supply of pure solvent. The conveyor mechanism and its support are separate from the degreaser tank proper. Provisions are made for automatic control of the condensing water, steam supply, and overloading of the machine.

The outstanding features are the large capacity of the machine for the small floor area used, its simplicity of construction and operation, the economy of solvent and the low cost of the cleaning.

A Temperature Indicator

Ample space for toggle-type switches, for connecting any one of a number of couples to the measuring circuit, is provided in a new temperature indicator made by the Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia. Installed wherever convenient, it enables an operator to measure temperatures of near or distant couples with equal reliability, by simply turning a knob, until a pointer comes to zero, and reading a temperature scale.

Use of a potentiometer measuring circuit, hand-standardized but with automatic reference-



junction compensation, eliminates uncertainties due to circuit-resistance variables. Scale is practically uniform and equally accurate throughout, and can be calibrated for single or double range, the latter for use with similar or different couples. Built-in terminals, check key and mercury thermometer can be included for checking with a portable indicator.

The rigid metal case mounts flush in panel, but can be equipped with hangers for surface mounting. The galvanometer is a sturdy replaceable unit. The only maintenance is occasional dry cell replacement. Warning that dry cell must be renewed is given when a red disc appears above the indicator scale.

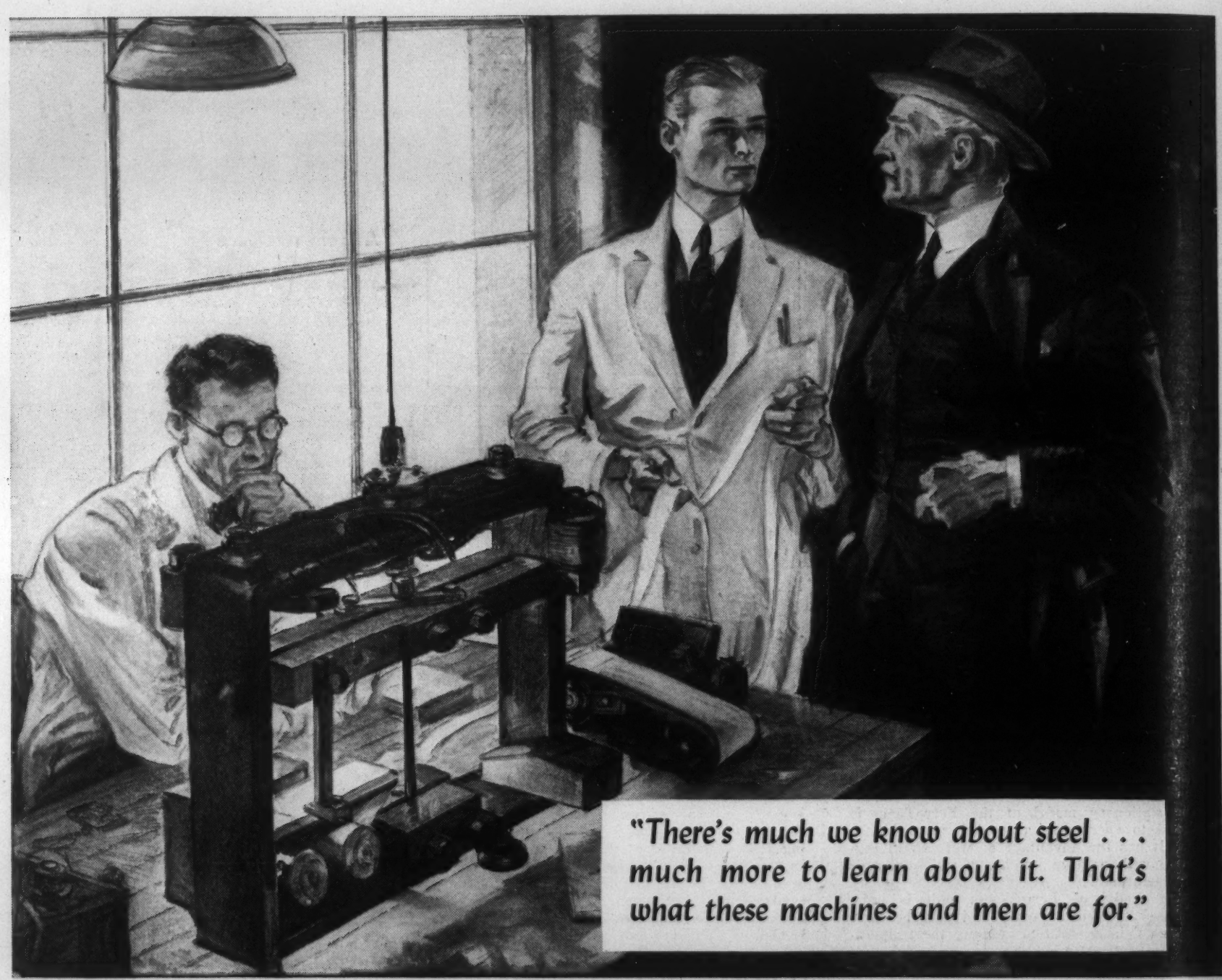
Separate selector switches can be used external to the indicator, if desired, or space for additional self-contained toggle-type switches may be obtained by assembling the indicator (with case removed) in a cabinet similar to that of the Micromax strip-chart recorder.

An Improved Sheet Mill

The Lewis Foundry & Machine Division of Blaw-Knox Co., Pittsburgh, announces a new improvement in its Lewis 3-high sheet mill. By streamlining of the mill tables, the rolling capacity of the mill is increased from a range of 1600 to 1800 pairs per 8-hr. turn to an output of 1700 to 2000 pairs.

(Continued on page MA 130)

STEEL YIELDS ITS SECRETS TO PRECISION INSTRUMENTS

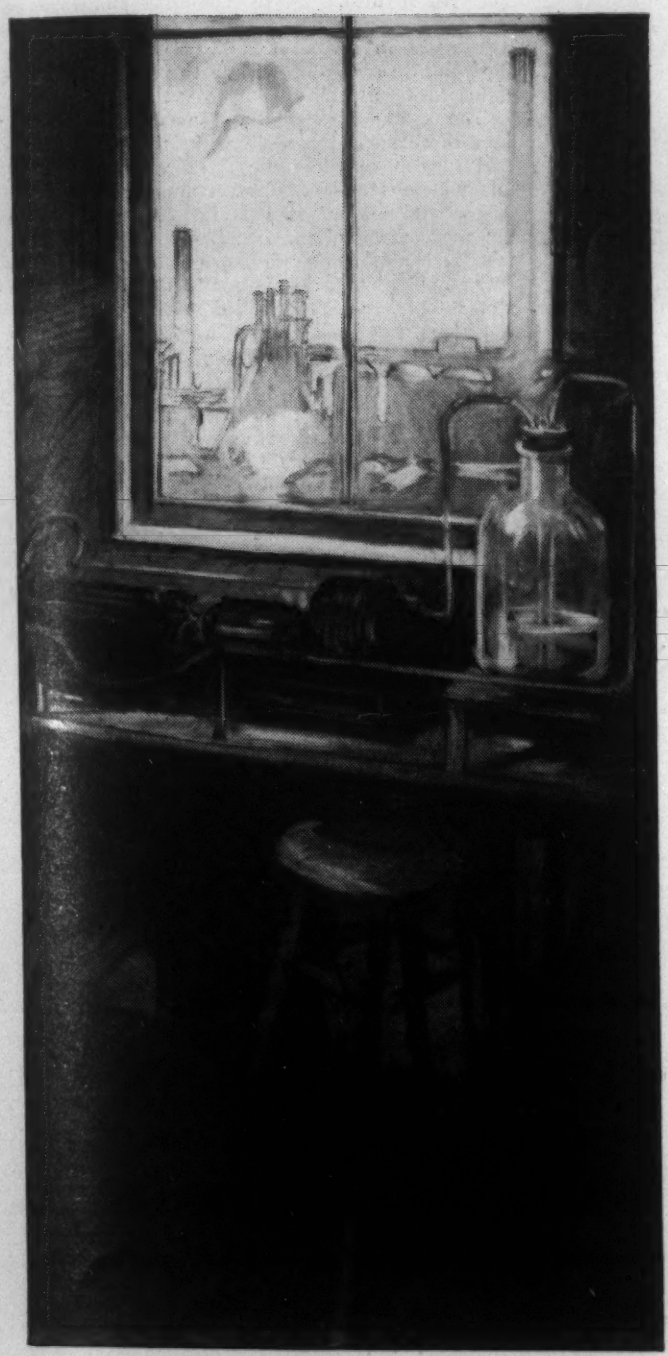


And J & L metallurgists, reading and recording these revelations, find new facts that help improve and control the quality of steel.

"Steel is a stripling in age among the metals. There's much we know about steel—much more to learn about it. That's what these machines and men are for — to catch steel's secrets as they are revealed on indicator and chart. We collect

and classify this inner story into workable formulas for improving and controlling the quality of J & L Steel.

"This instrument, called a damping capacity tester, is one of the first of its kind to be used in this country. The innumerable graphs it has drawn for us contribute greatly to our knowledge of steel quality.



From a drawing by ORISON MacPHERSON

"Here in our new Pilot Plant is a complete steel works in miniature—the first of its kind—with 'pint size' steel furnaces, and little rolling mills. Here also is installed a physical testing laboratory as scientifically equipped for its purpose and as well staffed with technical men as that of a great university or research institute. It belongs to a steel company — an old and experienced steel company that looks to the future with youthful eyes. That's how J & L intends to maintain its position in the manufacture of controlled quality steels.

"Applied physics — underwritten and encouraged by Jones & Laughlin. Why? To make better steel, to supply customers like yourself with steel that works better and endures longer, that helps you to produce profitably finer finished products — articles of use and beauty for better everyday living here in America."

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

PITTSBURGH, PENNSYLVANIA

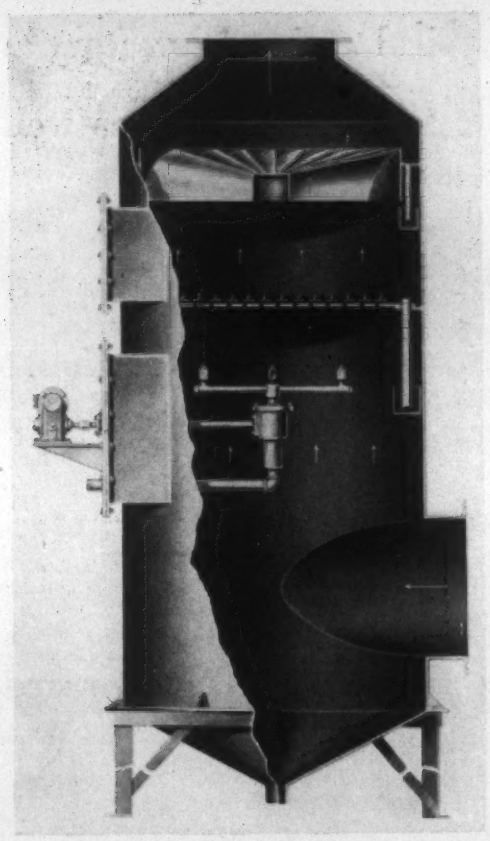
J & L — PARTNER IN PROGRESS TO AMERICAN INDUSTRY

J&L STEEL

Triple Action Scrubber

The Peabody Engineering Corp., New York, announces the development of a new model scrubber for the removal of fog, dust and other particles from gas and air. It is a simplified, perfected adaptation of the scrubbing principles which characterize the company's various designs.

The new model will be known as the "Peabody Triple Action Scrubber," the separation of impurities being a three-step process. Gas enters tangentially near the base of the scrubber and is there relieved of coarse particles by cyclonic action. The gas passes upward through a zone of water or scrubbing liquid, supplied by slowly rotating sprays, operating at only 10 to 15 lbs. pressure. Dust particles mingle with water droplets at this stage. Continuing its travel, the gas encounters a plate with coarse perforations. On passing through these, the velocity of the gas is greatly increased and with it the velocity of the dust and water droplets.



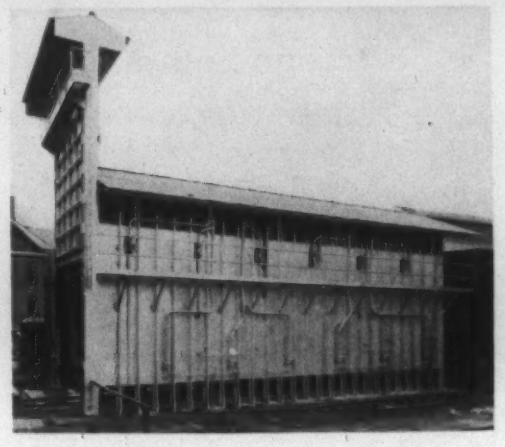
The mixture of gas, dust and droplets is shot through the plate perforations directly at square impingement baffles, constantly wet, arranged so that the stream coming through each plate perforation strikes its individual baffle at maximum velocity. The dust particles and water droplets, on impact with the wetted baffle merge with the water surrounding the baffle. At this point, the real and final cleaning takes place. The dust particles hit the baffle with the directness of point blank rifle fire and, upon doing so, are effectively and permanently captured in the scrubbing liquid.

A liquid overflow pipe, located slightly above the level of the baffles, carries off the dust laden water, which leaves at the bottom of the scrubber shell. The gas or air, freed from impurities, is deflected around the baffles and continues upward toward the outlet of the shell. Eliminator vanes, located below the outlet, entrap any droplets of water carried upward in the gas stream, thus delivering dry gas.

Great efficiency is obtained in small sized scrubbing units. An interesting comparison is provided by a Peabody scrubber, 4 ft. in dia. and 6 ft. in height, doing the same cleaning job as a packed tower double the diameter and 130 ft. high. A new bulletin describing and illustrating the Peabody Triple Action Scrubber may be obtained by writing to the company.

Car Bottom Stress-Relieving Furnace

The American Car and Foundry Co., New York, has recently installed in its plant at Milton, Pa., complete equipment for the manufacture of fusion-welded tanks. To the Milton plant is allocated, exclusively, the building of



tank cars, and it has a capacity of 600 such cars per month.

This equipment includes one of the newest of car-bottom stress-relieving and annealing furnaces, designed and built by Morris Engineering Co., Philadelphia. The furnace is constructed of Babcock & Wilcox insulating firebrick. The open bottom is claimed to assure minimization of rail and car warpage. The inside dimensions are: 47½ ft. by 13 ft.; 17 ft. 3 in. high. The brick thicknesses are: Side wall and end wall, 13½ in. insulating firebrick; arch and door, 9 in. of the same material; car top 3 in. B & W insulating concrete is covered by 7½ in. insulating firebrick and paved with 4½ in. dense firebrick. A typical annealing cycle, including heating up to 1550 deg. F. and cooling, was 7¼ hr. for a tank weighing 33,000 lb., the oil consumption being 306 gal. Outside conditions were winter weather of December, 1938.

Inkless Recording Instruments—Indoor or Outdoor

Continuous accurate operation for 30 days without attention, at temperatures as low as minus 10 deg. F. and as high as 120 deg. F., is made possible by the new Type CF-1 line of inkless recording single- and double-range a-c ammeters and voltmeters announced by the General Electric Co., Schenectady, N. Y. The units are in the low-price range and are particularly well suited for voltage surveys, complaint investigations, and checking circuit load conditions. The inkless mechanism, which uses a typewriter ribbon, to make the record by a series of dots, results in greater simplicity, small size, and lightweight. There is no inkwell to clean, no pen to start, and nothing to freeze in cold weather. A cast aluminum alloy case of modernistic design protects the mechanism and further suits the new instruments for service while exposed to the weather. Although they are portable, the new instruments may be wall or pole-mounted.

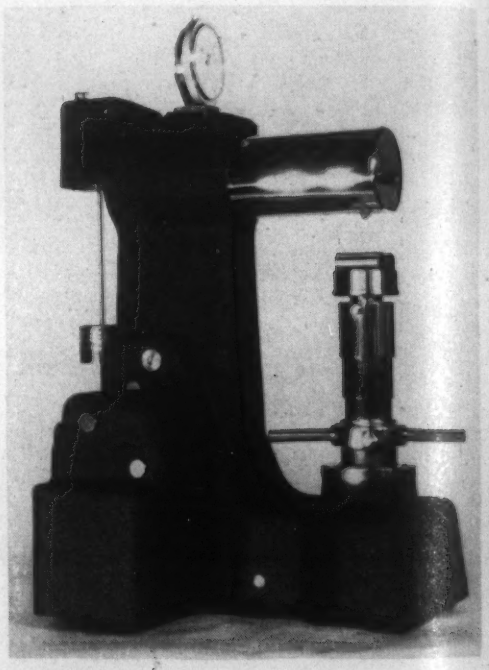
Voltmeters are listed for the double range of 0-140/0-280 volts. Ammeters are for 0-5/0-10 amperes. Single range instruments can be supplied. The voltmeter is accurate to within 1½ per cent of full-scale value over the scale range normally used; that is, 110 to 130 and 220 to 260 volts, and to 3 per cent outside those limits. Ammeters are accurate to within 3 per cent of full-scale value. Type CF-1 recorders have a net weight of only 11 lbs. and are 10 9/16 in. high by 8 9/16 in wide by 5 31/32 in. deep. The chart is 4 in. wide (3½ in. record space) and is driven by a Telechron motor at 1, 2, or 3 in. per hr. A second Telechron motor operates the inkless mechanism.

The new line imposes an exceptionally low burden on instrument transformers—only 1 volt-ampere for the 5-amp. ammeter or the 140-volt voltmeter at 60 cycles.

New Rockwell Models

The Wilson Mechanical Instrument Co., Inc., 383 Concord Ave., New York, offers a new Rockwell model, furnished either as a "Model 3-CR Rockwell Hardness Tester" or as a "Model 3-CS Rockwell Superficial Hardness Tester" designed for the purpose of internal testing of large tubes and cylinders. The cylindrical tube being tested is simply projected over the horizontal testing arm. These machines can also be used for testing outer surfaces. These models are made in an 8 in. vertical capacity, 6 in. horizontal reach and will test internal surfaces down to 4 in. I.D.

The same sensitivity and accuracy are built into these special models as in the regular line and they have the same durable precision and rugged construction. Correct application of both minor and major loads is insured through the patented, frictionless, free-floating plunger system and mathematically correct loads and leverages. The operation is semi-automatic through motor operation. Standard readings are obtained on these machines. One of the most interesting applications, in several plants, is in the testing of airplane engine cylinders having nitrided surfaces.



A Metal Cleaner

A new metal cleaner that instantly removes stains and oxides from copper, brass, bronze and other metals, except aluminum, iron and zinc has been announced by Rapid Electroplating Process, Inc., 1414 S. Wabash Ave., Chicago. It is marketed as "1-Second Metal Cleaner" and is reported to contain no abrasives. It cleans by chemical action only and requires no rubbing. It has a jelly-like consistency and is applied with a brush and immediately wiped off with wet rag and then dried.

The substance contains no free acid or caustic and will not etch or harm the metal in any way even if permitted to dry on the surface. It retards the re-forming of oxide and because it contains no abrasive, makes it useful for rendering working surfaces chemically clean without leaving any gritty residue. It also cleans crevices inaccessible to some cleaners and leaves no powdery deposit.

Ordinarily copper, brass and bronze must be regularly and laboriously polished, each operation leaving a powdery deposit in crevices and on surrounding areas. It is claimed that by use of 1-Second Metal Cleaner, deposits are removed and polishing need only be done very occasionally when surface becomes badly scratched or abraded. *(Continued on page MA 131)*

The "Alnor" Multi-Point Pyrometer

This "Alnor Rectangular Type Pyrometer" was designed by the Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago, to provide a rugged moderately priced instrument with multi-point switch, arranged for either back or bottom conduit connection and which would be fully water-proof, fume-proof and dust tight.

This pyrometer has proven to be exceedingly popular, not only with Diesel engine manufacturers, users, and engineers, for checking exhaust temperature, but it is also being used extensively for many industrial applications, which require close accuracy yet where a moderately priced multi-point pyrometer is desired.

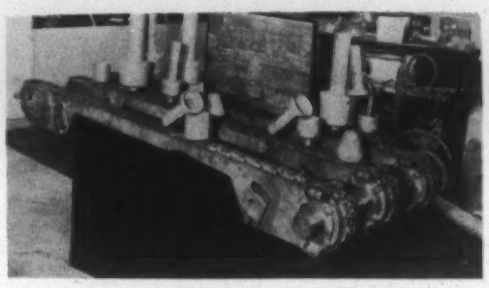
The movement of this pyrometer is ruggedly built and will withstand considerable vibration. However, where the instrument must stand severe jars and shocks such as when mounted on Diesel locomotives, shovels and excavators, a special shock resisting movement should be used. This will be furnished when specified at a nominal additional charge.

High accuracy is assured due to the simple, sturdy design, high torque, high quality of materials and workmanship. It has a scale 5 in. long with legible figures and sub-divisions. This with the broad spade pointer and fine needle provides quick accurate readings. The internal resistance is exceptionally high for this type of pyrometer. This assures greater freedom from errors caused by varying lengths of connecting wires.

The Flexi-Speed Carburizer

For some time the Timken-Detroit Axle Co., Detroit, and some other companies have been experimenting with a variety of unit or single containers for carburizing, in shape close to the contour of the object to be treated, mounting them on pusher trays of the usual type carburizing furnace. Despite the fact that this equipment (the unit container) greatly reduced the heating time, the warpage and improved the quality, the furnace capacity was also reduced because the area required was three times greater than that required for the larger carburizing boxes.

The experiments at Timken proved the advantages of the individual containers but the mechanics of moving these containers remained



unsolved for some time or until the General Alloys Co., Boston, introduced the "Flexi-Speed Carburizer." This is a special conveyor for moving the "stream-lined" containers through a furnace, as illustrated.

Some of the advantages claimed are as follows: (1) Permits absolute control of case depths with no experimenting—exactly predictable and repeatable results. (2) Handles mixed work of different case depth simultaneously, for example, a 0.030, 0.060 and 0.080 case may be run at the same time on different time cycles. (3) Is self-emptying. No costly waste and delays on each shut-down or change in cycle. (4) Can be run at any desired percentage of furnace production capacity. (5) Uses 80 per cent less compound per pound of work treated. (6) Employs minimum alloy weight per pound of work treated. (7) Eliminates "ram-rod" effect of pusher furnaces on alloy. (8) Low unit replacement cost. (9) Requires minimum size of furnace and floor area. (10) Offers a safe middle ground between box and gas carburizing.

A Cleaner, More Workable Clay

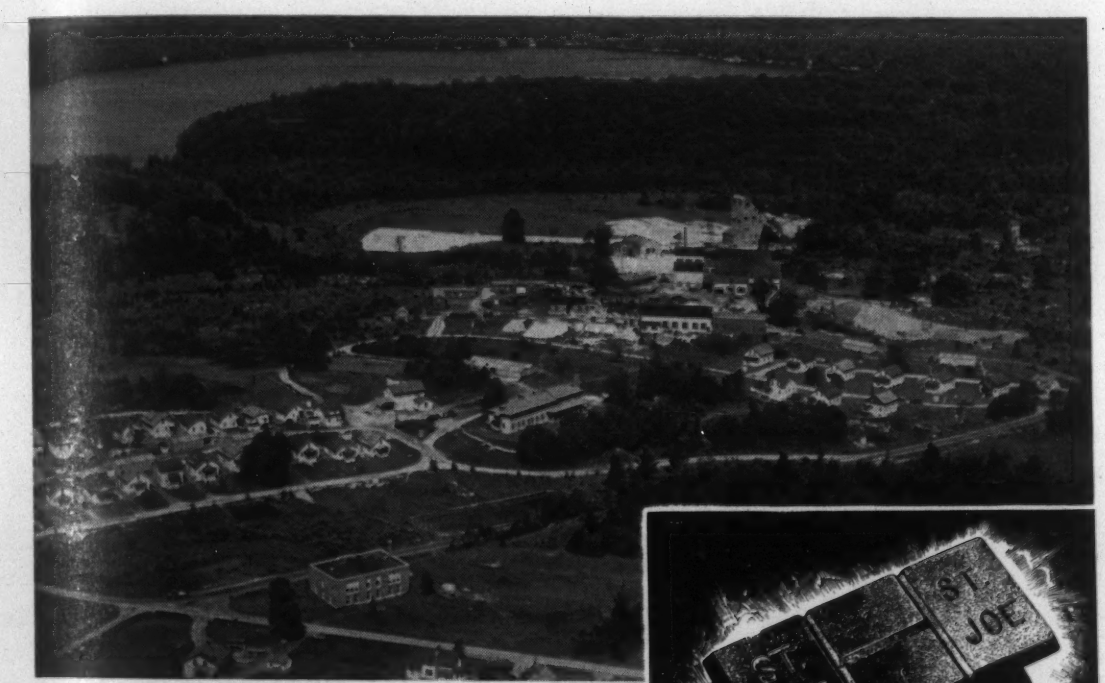
The Porcelain Enamel & Mfg. Co., Baltimore, Md., recently made the important announcement that it was about to introduce to the porcelain enameling industry a superior clay which had been refined by a new and revolutionary process. The material will be known as "Micronized Clay." A micronized product is one that has been broken down to a grain size ranging from one to 10 microns by the Micronizer reduction process. For purposes of comparison, the opening in a 200-mesh screen is 74 times larger than a micron. The material by this method is caused to grind itself rather than through contact with some other surface.

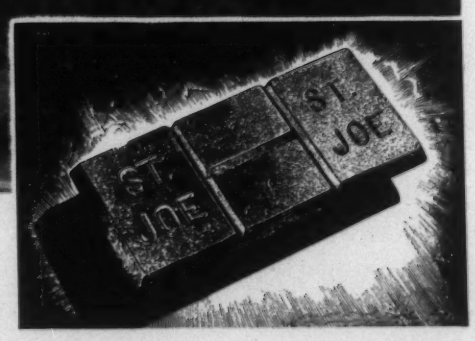
The refining of clay by the Micronizer process is claimed to insure a cleaner product; to increase efficiency through increased fineness; to be easier to handle; to reduce clay content; to have greater workability; to improve suspension; to have more rapid drain, and greater wetability; smoother set; and to reduce pitting and scumming to a minimum. All in all, Pemco Micronized Clay produces a finished product which is more durable and has closer texture.

(Continued on page MA 132)

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 1 of a Series





THE BALMAT MINE

The mine, mill and town of Balmat, New York, developed and built by the St. Joseph Lead Company during the last ten years.

CLOSE TO THE BEAUTIFUL FOOTHILLS of the Adirondack Mountains, hidden for untold centuries under forest and lake, lay the great zinc deposit now known as the Balmat Mine.

Developed in 1927 and 1928 by the St. Joseph Lead Company, this great ore body which on the surface was a thinly mineralized non-commercial limestone, is currently shipping, with the old "Edwards mine" ten miles away, 60,000 tons of zinc concentrates, and 70,000 tons of iron pyrites per year.

One of the greatest zinc deposits in the United States, its large ore reserves are available for the smelter and refinery of the St. Joseph Lead Company at Josephtown, Pennsylvania, where the new St. Joe electro-thermic grades of zinc are produced.

ST. JOSEPH LEAD COMPANY

250 PARK AVENUE • NEW YORK

ELdorado 5-3200

PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Welding Helmets and Hand Shields

Four new welding helmets and four new hand shields have just been announced by the American Optical Co., Southbridge, Mass. These helmets and hand shields are made of the best grade vulcanized fibre, in either fabricated or one-piece construction, and are designed for comfort, safety, convenience and durability.

The helmets have a new free-floating headgear and an outside friction joint as standard equipment. Three types of glass holders are available: "Deep-Drawn Leakproof Steel," "Improved Bakelite," and the new "Dowmetal Lift Front," all of which assure maximum protection for welding plates and cover glass. An exclusive feature will be noted in these holders: They hold the welding and cover glass in position flexibly, not rigidly, in order to cushion the shock if accidentally struck. Glass can be easily changed without smudging or risk of breaking.

The hand shields are compact, lightweight, and well-balanced. Corrugated fibre handle, of new design, is deeply grooved to insure a firm, positive grip.

DU PONT CYANIDES & SALTS

for your

LIQUID BATHS

NO MATTER what your heat treating requirement, Du Pont offers a complete line of efficient, economical Heat Treating Salts for every purpose . . . shallow or deep case hardening, reheating, nitriding, coloring, tempering or drawing. Our Technical Service Staff will gladly cooperate with you in the selection and use of the proper Du Pont Heat Treating Cyanides and Salts to meet your individual needs. Contact our nearest office.

PLAN TO VISIT THE DU PONT EXHIBITS at the GOLDEN GATE INTERNATIONAL EXPOSITION in San Francisco and at the NEW YORK WORLD'S FAIR

DU PONT

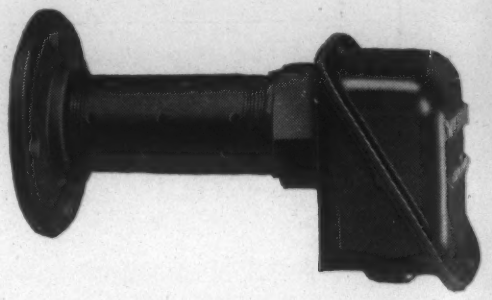
The R. & H. Chemicals Department
E. I. DU PONT DE NEMOURS & CO., INC.
Wilmington, Delaware

District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

Wheelco Photo-Head

The Wheelco Instruments Co., 1933 S. Halsted St., Chicago, has just introduced the "Photo-Head" (photo-electric receiver), an adjunct to the Wheelco Flame-Otrol safeguard. It is designed for fuels other than gas, burning with luminous flames. The Photo-Head takes the place of the standard electrode, using the same Flame-otrol and affording the same instantaneous protection against flame failure. It provides safe, supervised, automatic ignition of oil burners, making the application of automatic on-off control possible with intermittent or constant pilots.

The Wheelco Photo-Head is designed to act instantly upon flame failure in furnaces, boilers, ovens and heaters. It is sensitive to the characteristics of a luminous flame, but not responsive to heat radiation from combustion chamber. In conjunction with the Flame-otrol, it shuts down the fuel supply with lightning speed, preventing entry of unburned fuel into combustion unit and eliminates this source of explosion hazard.



In cases where combustion equipment uses combination fuels, such as pulverized coal and gas, oil and gas or pulverized coal, oil and gas, the Photo-Head is used in conjunction with the standard electrode. Bulletin A-1105 gives complete detailed description.

"Kennametal" Tools

The McKenna Metals Co., 158 Lloyd Ave., Latrobe, Pa., manufacturers of "Kennametal" tools and blanks for steel and metal cutting, has issued a new 24-page catalog which is now available to all plant operating and purchasing officials. Kennametal is manufactured in three grades—hard, medium and soft alloys, and designated as KH, KM and KS, depending on the metals to be cut. Grade KH is the most generally applied grade where only one kind of hard carbide is used, as it machines not only steel, but non-ferrous alloys, and malleable iron as well as taking interrupted cuts on cast iron.

The basic ingredient of the steel-cutting grades of Kennametal, a synthetic tungsten titanium carbide composition, is the new substance corresponding to the chemical formula $WTiC_2$ which was developed by Philip M. McKenna. The main use of this compound at present is as an ingredient in the manufacture of hard carbide alloys in the form of blanks for tool tips, drawing dies, lathe centers, gage parts, rings, balls, rolls and other shapes, all harder than any tool steel.

Current Metallurgical Abstracts

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MARCH, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation, Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2·REDUCTION

Blast Furnace Practice, Smelting and Electro-refining.

A. H. EMERY, SECTION EDITOR

Fixation of Sulphur from Smelter Smoke. Partial Pressures of Sulphur Dioxide Over Solutions of Sulphur Dioxide in Mixtures of Water and Various Aliphatic Amines. A. H. ROBERSON & G. W. MARKS. *U. S. Bur. Mines Rept. of Investigations* 3415, Oct. 1938, 45 pp. Research. All amines used were of commercial grade. Partial pressures of H_2O and SO_2 at 33, 50, 75 and 90° C. and 50, 60, 75 and 90% saturation of the following solutions are presented tabularly: Diethylene triamine (9.75, 18.01, 26.72 and 35.82%), triethylene tetramine (8.15, 16.13 and 25.41%), and monoethanol amine (no 50% saturation data) (11.53, 23.20, 34.69 and 46.81%). Limited data for the following solutions are presented: 21.65% ethylene diamine, 35.74% diethamol amine and 35.64% triethanol amine. These data indicated inferiority to the first group for the purpose in hand, and complete information was not obtained. Curves of relative viscosities of the 4 strengths of diethylene triamine solutions before and after saturation with SO_2 at 20-70° show gradual increase with increasing amine concentration before SO_2 saturation and enormous increases after. Densities of all solutions at 0, 25, 50, 60, 75, 90 and 100% SO_2 saturation, 25-85°, are shown tabularly. Volume changes from 0 to 100% saturation give J shaped curves, negative from 0 to about 90%, then rising very abruptly. The higher the amine concentration, the lower the curve drops, the quicker the break occurs and the higher the curve rises. Curves on SO_2 removal are presented. Boiling at 98-101° is more effective than heating at 91-93°. SO_2 removal decreases with increase in concentration, but not markedly above 60 mg. of amino N per cc. Extensive tables are presented showing concentration of H_2O, amine and SO_2 in all solutions and at all temperatures used in the partial pressure studies. The effective capacity of various solutions in g. SO_2/l. are 1:1 xylidine, 207; 9.82 g. $Al_2(SO_4)_2$/100 ml. solution, 74; ammonium sulfite-bisulfite—22.5 moles NH_3/100 moles H_2O, 171; 9.75% diethylene triamine (DET), 84.3; 18.01% DET, 124; 26.72% DET, 177; 35.82% DET, 207; 8.15% triethylene amine (TET), 64.2; 16.13% TET, 81.8; 25.41% TET, 119; 11.53% monoethanol amine (MET), 23.4; 23.2% MET, 57.6; 34.69% Met, 74.5; 46.81% MET, 94.5. Recent articles and patents are reviewed. AHE (2)

2a. Non-Ferrous

Furnace Charge Descent. A. J. BOYNTON (H. A. Brassert & Co.) *Steel,* Vol. 103, Oct. 17, 1938, pp. 50, 52-53. Aside from support afforded moving charge along walls of blast-furnaces, additional support is probably provided by columns of coke extending radially from tuyeres to central mass of stationary coke. In a furnace working correctly, stock movement is largely within an annular space adjacent to walls, until a depth is reached at which the furnace diameter is equal to that of hearth. Below this point, descent is less close to walls. Descent to tuyeres is through an annulus that becomes something like a circular system of funnels as tuyeres are approached. All the slag-forming elements and the Fe descend in outer annulus. First necessity for successful blast-furnace operation is a smooth and uninterrupted descent of charge. With correctly designed furnace and reasonably good size preparation of stock the chief factor in smooth descent is a thoroughly melted and fluid slag in the furnace region that lies between a point a little above head of bosh and the point shortly above tuyeres where coke begins to burn. The furnace produces more Fe with less fuel as bosh slags become more acid (up to consistency of charcoal slags) because blast temperatures as high as the stove equipment can generate can be used. Operation with refractory bosh slags prevents full application of hot blast. Furnaces with refractory ores or high-ash coke, or those located in a moist climate, may be improved economically by reducing limestone in burden and substituting desulphurizing treatment outside the furnace or by using a tuyere that can increase the area within which the coke is burned, thus increasing ease with which stock may descend to tuyeres. A variation developed by Carl Steinbacher has a 22½° lateral angle and is claimed to have improved operation by ability to carry blast temperatures above 1600° F. with uniform blast pressure and stock movement. Probably this tuyere causes change in the radial coke piers between the tuyeres to permit easier descent of charge. MS (2a)

Hot Blast Stoves. JAMES P. DOVEL. *Steel,* Vol. 103, Oct. 24, 1938, pp. 43-44. Method of increasing operating efficiency is suggested. Blast temperatures have been limited to 1300°-1400° F., as otherwise stack and peak temperature in the stove would go too high. Experiments were made using extra stoves changed every 30 min. to prevent damage to them. For each 100° F. rise in temperature, 5% ore was added. Under these conditions, stack temperatures reached 900° F., without damage to the blast-furnace equipment. About ⅝ of this waste heat was recovered by passing cold-blast counter-current through a recuperator similar to the old pipe stoves; waste-gas temperature was lowered to 400°-450° F. By mixing and burning some live gas with the inert gas entering the recuperator under thermostatic control, a straight-line heat chart is possible. Attainment of blast temperature of 1800° F., which will melt slag freely and represents ideal operating conditions, would save $1-$1.50 per ton, which can be accomplished on any furnace plant at a cost less than that of an additional stove. MS (2a)

2b. Non-Ferrous

Equilibria between Aluminum and Sodium with their Chlorides and Fluorides in the Molten State. Contributions on Equilibria between Metals, Sulfides and Silicates in the Molten State. No. 6 (Die Gleichgewichte zwischen Aluminium und Natrium mit ihren Chloriden und Fluoriden im Schmelzflusz. 6. Mitteilung über Gleichgewichte zwischen Metallen, Sulfiden, und Silikaten im Schmelzflusz) W. JANDER & H. HERRMANN. *Z. anorg. allgem. Chem.,* Vol. 239, Aug. 12, 1938, pp. 65-81. Experimental. The reaction $3NaCl + Al \rightleftarrows 3\,Na + AlCl_3$ between 800° and 900° C. goes strongly to the left. The ideal mass action law is obeyed to a first approximation. The very small displacement of equilibrium with temperature is hard to reconcile with the difference in heats of formation of NaCl and $AlCl_3$, considering especially that molten $AlCl_3$ probably exists as $(AlCl_4)^-$ ions. The equilibrium $3NaF + Al \rightleftarrows 3Na + AlF_3$ is less displaced to the left at 1090° C. than in the chloride system, possibly because the Al is more strongly bound in the complex $(AlF_6)^{---}$ than in $(AlCl_4)^-$. The curve relating Na concentration in the metal to the Al content of the slag shows a decided break at 12.8% Al, the composition of $Na_3(AlF_6)$. Above this point the Na content of the metal quickly falls to around 0.004% Na, agreeing well with the Na content of un-remelted commercial electrolytic Al. If the Al content of the slag is less than 12.8%, about 10 times as much Na dissolves in the metal, and at 1% Al in the fluoride, the Na content of the metal rises to 0.1%. From the equilibrium constants above and below 12.8% Al, the dissociation of the $(AlF_6)^{---}$ complex ion could be determined. In pure cryolite melts this amounts at most to 1-2% at 1090° C. HFK (2b)

The Dwight-Lloyd Blast Roasting Section for Sintering Lead Ores at the Broken Hill Assoc. Smelters Proprietary, Ltd., Port Pirie, South Australia. P. J. WALSH. *Proc. Australasian Inst. Mining Met.* No. 107, Sept. 30, 1937, pp. 133-156. Descriptive. Average composition of charge for year ending July 1, 1937, was Pb concentrate 50.89, limesand 4.20, siliceous ore 5.24, electrolytic Zn Coy's residues 8.28, ironstone 1.17, crushed quarry slag 4.63 and granulated slag 25.59%. Detailed chemical analyses of concentrates from various mines and of the other components of the charge are tabulated. A portion of the S is eliminated in a preroast on standard Dwight-Lloyd machines. This sinter is crushed and reroasted on D-L's. Final sinter analyzes Pb 47.12, SiO_2 7.43, FeO 14.95, MnO 2.56, CaO 5.59, Zn 10.0, S 2.1% and Ag 17.5 oz./ton. Baghouse material from preroast analyzes SiO_2 0.4, FeO 1.7, MnO 0.38, CaO 0.96, MgO 0.18, Al_2O_3 0.12, Zn 2.35, S 9.2, Cl 4.8, Cu 0.12, As 0.33, Sb 0.16, Cd 1.194, Pb 65.0% and Ag 12.4 oz./ton; dust from final roast is similar. Baghouses, sintering machines and accessories are described. AHE (2b)

3 · MELTING, REFINING AND CASTING

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Progress in the Field of Metal Separation (Fortschritte auf dem Gebiete der Metalltrennung) W. KROLL. *Metall u. Erz,* Vol. 35, Nos. 10, 11, 1938, pp. 252-254, 282-286. Discussion and review of literature. The applications and limitations of metal purification of metals by oxidation, and the possibilities in purification through the introduction of metals having high affinities for the impurities, are considered. A theoretical treatment of metallic systems, intermetallic compounds and their heats of reaction precedes a discussion of practical applications. Many possibilities for the use of Si, B, C, Zn, Al, alkaline and alkaline earth metals as purifying agents are considered. Some of the more important applications are summarized in the Table:

Base	Impurity	Present as	Precipitant	Precipitate
Pb	Bi	In soln.	Ca	Bi_2Ca_3
Pb	Sb	" "	Na	NaSb
Pb	As	" "	Na	NaAs
Pb	Au	$AuPb_2$	Zn	Au_3Zn_5
Pb	Ag	In soln.	Zn	Ag_2Zn_3
Pb	Cu	" "	Si (Al)	Cu_3Si
Pb (Tl, Bi)	Cu	" "	S	Cu_2S
Sn	Sb	" "	Zn	Sb_2Zn_3
Sn	Sb	" "	Na	Na_3Sb
Sn	As	AsSn	Mg (Na, Ca)	NaAs
Sn	Fe	Fe_3Sn	Si	FeSi
Sn *	Cu	Cu_3Sn	Si	Cu_3Si
Sn *	Cu	"	S	Cu_2S
Sb *	Cu	Cu_5Sb_2	Si	Cu_3Si
Sb	Fe	Fe_3Sb_2	Si	FeSi
Al	Fe	$FeAl_3$	Ce	Ce_2Fe_5
Al	Fe	$FeAl_3$	Be	$FeBe_2$
Al	Ti	Al_3Ti	N_2	TiN
Fe	S	FeS	Mn, Be	MnS, BeS
Fe	C	In soln.	Ta, Cb	TaC, CbC
Fe	B	" "	Ti	TiB_2
Zn	Fe	$FeZn_7$	Al	$FeAl_3$
Cu	Sb	Cu_3Sb_2	Na	NaSb
Cu	Ti	CuTi(?)	N_2	TiN
Mg	Si	Mg_2Si	Fe	FeSi
Ca (Ba, Sr)	Si	$CaSi_2$	Fe	FeSi

* Only when much Pb is present.
34 references. PCR (3)

Physico-chemical Effects of Supersonic Waves (Physikalisch-chemische Wirkungen von Ultraschallwellen) E. HEIDEMANN. *Arch. Eisenhüttenw.,* Vol. 12, Oct. 1938, pp. 185-193. Descriptive. Magnetostrictive, piezo-electric, and air jet methods of producing supersonic waves are briefly discussed. Conditions of labile equilibrium are disturbed by supersonic waves. In liquids, the waves may cause chemical reactions to start by activation of dissolved gases. The waves may cause highly polymerized substances to form. Surface passivity is decreased and the electrolytic deposition potential of gases is generally lowered. The waves also have photochemical effects producing luminescence in liquids. In colloids, dispersion and coagulation may be produced in liquids and in aerosols. Dust and moisture may be separated from smoke and fog. Metals may be improved by supersonic waves—grain refinement was produced in light metals and low melting alloys. While the waves can no doubt be applied for test purposes, no such practical uses have yet been made. SE (3)

Italian Plant Features High Frequency Furnaces. M. KAUCHTSCHISCHWILI. *Iron Age,* Vol. 142, Sept. 22, 1938, pp. 40-44. Practical description of high frequency furnaces at the works of Cogne Co., Aosta. Furnace plant consists of 4 furnace units of 8 tons, 6 tons, 1760 lbs. and 330 lbs. each. Advantages claimed for high frequency furnaces are: Production of absolutely pure and high grade products, their instant readiness for operation, convenient regulation and high degree of economy. Includes tables giving operating characteristics for both the 6 and 8 ton furnaces for a certain period. VSP (3)

Induction Furnaces for Rotating Liquid Crucibles. E. P. BARRETT, W. F. HOLBROOK & C. E. WOOD (U. S. Bur. Mines) *Metals Tech.,* Vol. 5, Dec. 1938, T. P. 986, 12 pp. Descriptive. A high-frequency laboratory furnace with a rotating liquid crucible was used in certain slag-metal studies. Details of construction of 3 such furnaces are given. One furnace held 4½ lbs. of molten ingot Fe and, when rotated at 280 r.p.m., formed a liquid crucible approximately 2¾ in. internal diameter at the top by 2¼ in. deep. JLG (3)

Patterns Must Be Good. VAUGHAN REID (City Pattern Works) *Foundry,* Vol. 66, Oct. 1938, pp. 26-28, 50; Nov. 1938, pp. 27-28, 78. Practical discussion. The importance of proper apprentice training is considered and pattern design, use of proper lumber and method of construction described. For master pattern work, northern cork white pine is recommended, while for working patterns, Mexican mahogany is suitable. If metal pattern castings with smooth finish where they will not be machined is wanted, white pine should be used for master patterns. Flake glue seems to be the best. As for shellac, a grade A orange flake shellac free from rosin and not bleached with arsenic is recommended. VSP (3)

Seals Mold Surface without Flame. A. H. WAYCHOFF. *Foundry,* Vol. 66, Sept. 1938, p. 66. Brief practical description of a method of curing trouble with molding sand cutting or sloughing on small intricate castings. Use a fly sprayer and fill with Na_2SiO_3 and H_2O in equal proportions and spray mold face lightly with mixture, which will dry quickly. Spray face again heavily and let dry for about 30 min. Treatment prevents sand cutting by hot metal and makes a smooth casting without sand holes. May be used in casting brass, Al, Cu or Fe. VSP (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

Shrinkage and Contraction of Cast Iron. A. A. TIMMINS. *Foundry Trade J.,* Vol. 59, Sept. 15, 1938, pp. 191-193. Review plus original research. Cast Fe shows 3 distinct volume changes: (1) During the liquid state (liquid shrinkage), (2) solidification shrinkage, and (3) solid shrinkage. Liquid shrinkage is directly proportional to the temperature drop. Composition does not materially alter the volume change. Solidification shrinkage is governed by: (1) The C content, and (2) the condition of C. White irons all show a volume decrease on solidification; this decrease is a maximum at 1% C and a minimum at 4.3%. In gray Fe there is also a contraction in volume when the C is low, but as the amount of C is increased, the contraction decreases, and is eventually offset by an expansion when C reaches eutectic composition. This is because the formation of graphite during solidification causes an increase in volume. Solid contraction depends on composition and the rate of cooling of the Fe. White irons contract in a manner similar to pure metals, except that at about 700° C. an expansion occurs, owing to the change of austenite to pearlite. Low-phosphorus gray irons contract to a lesser degree, because some graphite is precipitated during cooling in the solid state, with an accompanying expansion that tends to offset the normal contraction. Therefore, the addition of carbide stabilizers or faster rate of cooling will increase the contraction by retaining more C in the combined form. High-phosphorus irons contain large quantities of phosphide eutectic that remain liquid after the main part of the Fe has solidified, and on solidifying at 950° C. give an expansion. The effect of total C and P on an Fe containing 2% Si in the high C series was investigated. Porosity appeared at 0.3% P and increased in amount as P was raised. With the lower C (2.6%) porosity did not appear until about 0.75% P was reached. Thus, as P is raised the C content must be progressively decreased in order to have castings free from porosity. Both Si and P increase porosity when the total C is high. The porosity present in high C irons may to a large extent be due to the openness caused by coarse graphite flakes. Si and P lower the amount of C required for the eutectic composition by the amount equal to 0.3% for every per cent. When a large mass of high-C iron containing high Si or P cools down, a certain amount of graphite will be precipitated before the Fe solidifies, and, having greater facility for growth, will be present as coarse flakes imparting openness to the Fe. As the Fe is still liquid, these constituents cannot cause any useful expansion. When the Fe freezes, there is less C available for expansion and the Fe is porous. Influence of section thickness, effect of pouring temperature, contraction and its relation to warping and cracking are also discussed. AIK (3a)

Desulphurization of Pig Iron (Beiträge zur Entschwefelung des Roheisens) W. OELSEN. *Stahl u. Eisen,* Vol. 58, Nov. 3, 1938, pp. 1212-1217. Original research. After a brief discussion of the fundamentals of desulphurization of pig Fe with Na_2CO_3 and Na silicates, and of the detrimental effect of SiO_2 in the slag and Si in the pig Fe, the favorable effect of CaO on desulphurization is brought out. CaO not only combines with some of the SiO_2, but also makes the slag more basic and combines to form CaS. CaO is especially effective after it dissolves in the slag, and additions of fluorspar help bring this about. The presence of even a small content of Mn in the pig Fe strongly increases the desulphurization by means of Na_2CO_3. The desulphurizing effects of the alkali carbonates are shown, Na_2CO_3 being by far the strongest and the effects of the others decreasing in the following order—K_2CO_3, $BaCO_3$, $SrCO_3$, $CaCO_3$. The addition of fluxes, such as CaF_2, $CaCl_2$ and other chlorides greatly increased the desulphurization, not by the action of the fluxes themselves but because they made the CaO and $CaCO_3$ fluid, in which condition the latter could react with and remove S. Na_2CO_3 is a very good flux for $CaCO_3$ but not for CaO; with $CaCO_3$, Na_2CO_3 forms a low melting (813° C.) double carbonate $Na_2Ca(CO_3)_2$. In line with the generalization that desulphurization takes place more readily under reducing conditions, it is shown that basic Bessemer and basic O.H. slags have a much stronger desulphurizing action on pig Fe than on steel. SE (3a)

The Effect of Deoxidation Treatments on the Ductility of Cast Steels. ALBERT P. GAGNEBIN (Internatl. Nickel Co.) *Trans. Am. Foundrymen's Assoc.,* Vol. 46, Sept. 1938, pp. 133-155. Research. The ductility of heat-treated cast steel is directly related to the distribution of sulphide inclusions. Steels with chain-like sulphides, arranged in a network around the primary grains, have low ductility because stress concentrations cause failure through the sulphide links, whereas steels with globular sulphides randomly distributed have high ductility. The arrangement of the sulphides depends largely on the O content of the melt, a high O content causing random distribution and a low O content resulting in the network formation. A critical amount of O is required for sound, ductile steel, and it is difficult to control this important variable; porosity may develop because of insufficient deoxidants, or low ductility may result because of a deficiency of O promoted either by reducing conditions during melting or by the use of a strong deoxidizer, such as Al. A melting practice was developed involving oxidation of the melt, then deoxidation with Si-Mn, Ca and Al, which thoroughly kills the steel, produces random sulphide distribution and consistently results in steels having high ductility, high impact resistance and high yield ratios. CEJ (3a)

Freezing of Rimmed Steel. HENRY D. HIBBARD. *Iron Age,* Vol. 142, Oct. 13, 1938, pp. 69-70, 72, 74, 76. Practical description of what happens during teeming and freezing of rimmed steel by considering the sequence of gas liberation in the mold, and results of such liberations on character of steel ingot. Skin-holes have been found filled chiefly with H_2 gas, and intermediate holes chiefly with CO. Central holes are thought to be filled with N_2 or NH_3. Sources of H_2 in fluid steel includes: (1) That in crude Fe of the charge; (2) H_2O vapor or steam in the air used in making producer gas; (3) H_2O vapor in the air used for combustion; and (4) H_2O vapor formed by combustion of H_2 in fuel. The only agency that drives off H_2 is the boil. Mn tends to check boil and, for this reason, should not be too high in charge. Cooling and freezing of metal are gradual and continuous throughout, from beginning of teeming until ingot is solid. The most important effect of effervescence in the mold is to carry off H_2 that survived the boil. Proper effervescence in mold is essential. If rate is too slow, H_2 holes form too near the surface because saturation comes sooner. Considers also segregation and scum formation. VSP (3a)

New Resistance Melting Furnaces (Neue Widerstandsschmelzöfen) O. GENGENBACH. *Elektrowärme,* Vol. 8, Oct. 1938, p. 260. Recent investigations of the change in charge composition during melting in a furnace with a graphite heating element showed that no increase in C occurs, and that rather, especially in high-alloy steels, a slight loss in C takes place. The results of 8 melts of tool and rustless steels of various composition are given in detail; the melting temperatures were between 1500 and 1600° C. The furnace had a lining of corundum cement. The average melting time was 54 min., and the average energy consumption 1 kw. hr./kg. Ha (3a)

Influence of Some Melting Factors on the Quality of Roller Bearing Steel. A. F. MYRTSYMOV. *Metallurg,* Vol. 13, Jan. 1938, pp. 39-54. In Russian. Practical. The most successful means to combat oxides in roller bearing steel are as follows: Proportioning the charge so that, upon melting, it will have not less than 1.35-1.40% C and not less than 0.5% Mn. The boil should last for 1 hr., 10 min. Mn should not drop below 0.20% during melting. At the end of boiling, the C should be 0.80-0.85%. Refining under a carbide slag should last for 2 hrs. or 2 hrs., 15 min. to carburize the bath by 0.05-0.10%. BZK (3a)

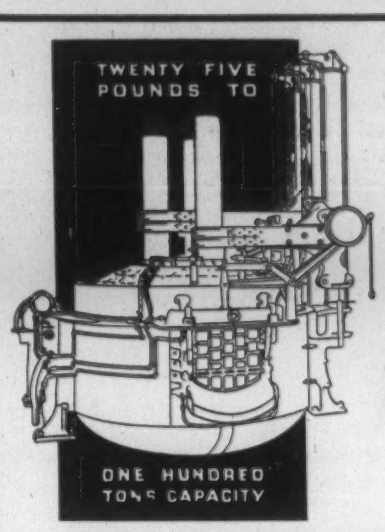
Open Hearth Design and Construction. GEO. L. DANFORTH, JR. *Blast Furnace Steel Plant,* Vol. 26, Dec. 1938, pp. 1183-1187. Practical. Outlines lay-out and equipment of modern open-hearth steel plant and discusses design and construction of a modern 125-175 ton open-hearth furnace. Pan-type hearth is generally preferred. For a furnace tapping 150-ton heats, the bottom could well consist of 3½ in. of insulation. 7 in. of first quality fire-brick, 4½ in. of chrome brick, 9 in. of magnesite brick and 19 in. of sintered magnesite mixed with 15-20% of open-hearth slag. Hearth area should be 5-5½ sq. ft. per ton steel cast per heat, when hearth is measured on sill elevation inside of 18 in. of brickwork in front and back walls and 22½ in. at ends. Binding should be of rigid or semi-rigid type and self-supporting. Front buckstays should be of slab type, H_2O cooled. Rear buckstays should be of slab type, formed with proper angle for full sloping back wall. Port end and slag pocket binding should be of heavy steel sections. Door and door-frame should be H_2O cooled, the latter tapered. Prefers straight ring ribbed roof. 18-in. roof with 22½-in. ribs gives most economical total results on a 150 ton furnace, and should be good for at least 350 heats. Skewback channels on entire roof should be suspended on rods rather than fastened rigidly to buckstays. Venturi-type port should be used so that flame extends 2/3 the distance from port to port and does its maximum work on incoming end of hearth. When preheated gas is used for firing, 2 slag pockets divided by a substantially built, gas-tight division wall are required. Size of air slag pocket should be 1½ times that of gas pocket. Regenerator chambers should be of ample cubical capacity, but need not be oversize. Prefers chambers with common division wall. Air chamber should be 1½ times as wide as gas chamber, and spring of the 2 roofs should balance their thrusts. Checkerwork should provide stable construction, adequate brick mass for heat storage, large amount of exposed brick surface for heat transfer, and passageways for free and well distributed gas flow, and should have reasonable cost for installation and maintenance. Brick shape used mostly is 9 x 3 x 4½ in. MS (3a)

The Strength and Ductility of Cast Steel during Cooling from the Liquid State in Sand Molds. Part II. H. F. HALL. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 73-86. Original research. Tensile tests were made with apparatus described in the Second Report for determining the properties of cast steel during cooling in the mold. An increase in the Mn content to 1.2% in 0.18% C steel caused a very slight lowering of the temperature at which ductility set in, followed by a rather quick increase in tensile strength and elongation. A further increase in Mn to 2.5% had relatively little effect. High S (0.07%) caused a pronounced lowering of the temperature at which the steel acquired ductility and a marked decrease in tensile strength at temperatures down to well below 1200° C. Tests were also made on high-C and high-alloy steels, and on low-C steels at a slower rate of straining. A test to indicate the susceptibility of a steel to hot tearing was developed. It consisted of a casting composed of a set of test bars of graduated size. Each test bar possessed end flanges and an enlarged middle portion, or bulb, which, by reason of its delayed cooling, predisposed this part of the bar to failure. These bars fractured by contraction pull when critical values of the bulb dimensions were exceeded. The controlling factor could be varied by a change in the ratio either of the length or of the diameter of the enlarged portion to that of the rest of the bar. Such a casting, when used in connection with the tensile tests, would afford a direct comparison of the susceptibility to contraction cracks with the tensile data determined. For Part I, see *Metals and Alloys,* Vol. 8, Aug. 1937, p. MA 507 L/4. JLG (3a)

Heat Transfer. C. H. VOM BAUR. *Steel,* Vol. 103, Oct. 31, 1938, pp. 40-41, 62. Practical. Limiting the rate of heat input to an electric arc melting furnace resulted in increased economy and efficiency. As heating or melting of metal is limited by efficiency of heat transfer through it, application of heat at rates above this value adds to losses. Results of 377 heats in a 2-3 ton Héroult furnace, used for making acid steel for casting from steel scrap, are presented. Voltage was 110 volts per phase, inherent reactance was 10-12%, and no choke coil was used. After a campaign operating with all power available during melting, charging and melting practice were changed, graphite electrodes used and power reduced from 1900 to 1520 kva. Best results were obtained by using about 360 kw. per ton charged during the melting period. Comparison of 105 heats in each campaign, with the same side-wall number, showed an average of 694 kw-hr. per net ton when using all power available, and 647 with reduced power. Difference in kw.-hr. during this time was 15,400, or, at $.016 per kw-hr.; $246.40 more for electricity and $36.75 for electrodes. Time saved was only 2½ hr. When a 12-in. diameter C electrode, formerly used, was too short to function, the entire electrode aggregate was pulled out, thus losing heat in the hot end. In the new set-up, a new 8-in. graphite piece was added to the hot remainder in furnace, resulting in a saving of about 38 kw.-hr. per net ton. MS (3a)

Mechanism of Solidification and Segregation in a Low-carbon Rimmed-steel Ingot. ANSON HAYES (Am. Rolling Mill Co.) & JOHN CHIPMAN (Mass. Inst. Tech.) *Metals Tech.*, Vol. 5, Dec. 1938, T. P. 988, 41 pp. Original research. An experimental and theoretical study of segregation in rimming-steel ingots of low-C steel is presented. According to the general theory developed, segregation results from the distribution of impurities between solid and liquid. A second major factor is the formation of an enriched film in the liquid adjacent to the solidifying interface and the entrapment of part of this film in the growing crystals. This entrapment is in turn greatly affected by rate of solidification and rate of stirring, the latter being almost entirely dependent on gas evolution. A further contribution is the loss of C and O by gas evolution and of the latter by precipitation of non-metallics. A mathematical treatment is presented that applies to a simplified hypothetical type of segregation in which equilibrium exists between solid and liquid phases, and the enriched film is completely mixed with the bulk of the solution. Such a process would yield the maximum segregation. The literature on the distribution of impurities between solid and liquid Fe is critically reviewed in the light of thermodynamics, and a table of distribution ratios and segregation coefficients is given. The ingot selected for experimental study was from a heat of mild steel, which has been used in the previously reported study of evolution of gases. The ingot was sampled from surface to center at points corresponding to 1/5, 1/2 and 4/5 of its height. The study included determinations of O and N by vacuum fusion. As solidification proceeds the concentration of impurities in the solid metal decreases to a minimum at a depth of 2 to 3½ in., then increases to a maximum at a depth of 4 to 4½ in. where the secondary blowholes occur. From this depth to the center the composition is practically constant. Longitudinal segregation of impurities towards the top of the ingot is particularly noticeable in connection with S and C. The average composition of the ingot, found by integrating the analytical results, is in agreement with the ladle analysis, except for C, where it is 0.028% lower, and O, which was not included in the ladle analysis. From the ladle and ingot analyses, the gas-evolution data, and from samples taken from the residual liquid during solidification, it is shown that the total amounts of both C and O in solid, liquid and gas phases during solidification are essentially constant. A study of the distribution of non-metallic inclusions was made. In the further development of the theory of segregation, based on results of experimental study, it was necessary to estimate carefully the composition of the liquid during solidification. It is shown that a vertical concentration gradient exists during the rimming period and that it gives rise to longitudinal segregation. The cause lies in the elevation of parts of the enriched film by upward currents near the solid surface. The entrapment of a fraction of the excess impurities in the enriched film is studied mathematically and the fraction entrapped is calculated from the simultaneous compositions of solid and liquid metal. S and Cu show essentially the same entrapment, while a much smaller fraction of C and O is entrapped. The entrapment figures for S are considered more dependable than those for the other elements. Assuming that the fractions entrapped are the same for Mn and Cu as for S, it is possible to compute the segregation curves for these elements in the middle cut of the ingot. The calculated curves are in good agreement with the analytical results. Similar methods are applied to the entrapment of C and O on the basis of the assumption that part of the enriched film is evolved as gas and that the fraction of the remainder entrapped in the solid is the same as for the nonvolatile elements. On this basis the fraction of the film evolved as gas is computed, as well as the total weight of C and O evolved from the film. The film loses about 3/10 of its C content and more than ½ of its O. The total C and O losses are known from the rate of gas evolution. The greater part of the C and less than ½ of the O evolved have their origin in the enriched film itself, the remainder coming from the adjacent liquid. JLG (3a)

Judging the State of Refinement in the Basic Bessemer by Analyses of the Outgoing Gases (Beurteilung des Ablaufes des Frischens in der Thomasbirne mit Hilfe der Abgasanalyse) R. FRERICH. *Stahl u. Eisen*, Vol. 58, Oct. 20, 1938, pp. 1138-1143. Review plus original research. The outgoing gases during the basic Bessemer blow were determined, data being presented mainly on the relative amounts of CO and CO_2 given off during the course of the blow. While the C is being burned out, the outgoing gases contain about 30% CO and 5% CO_2. The author has attempted to calculate the degree of oxidation of the bath from the amount of O put into the blast and from the amount of CO and CO_2 given off. At the height of the blow, when the C reaction with O is very lively, there is a slight reduction in the FeO content of the bath. This is only while there is still considerable C in the bath; as soon as the C burns down to below about 0.2% the bath is very rapidly oxidized. Rapid determination of the outgoing gases may prove of aid in controlling the Bessemer blow. SE (3a)



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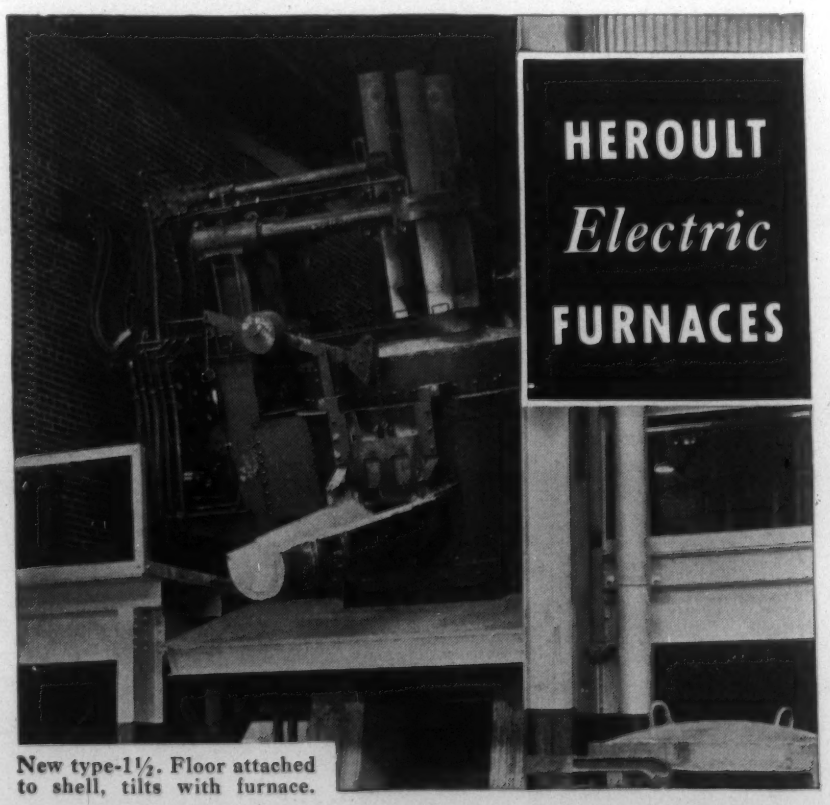

New type-1½. Floor attached to shell, tilts with furnace.

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UNITED STATES STEEL

The Graphitization of Cast Iron (Ueber den Vorgang der Graphitisierung des Gusseisens) E. PIWOWARSKY. *Giesserei,* Vol. 25, Oct. 24, 1938, pp. 523-533. Review plus research. The process of graphite formation is well understood for C- and Si-rich cast Fe, in which the graphite can crystallize directly from the melt; not so simple, however, are the conditions permitting direct or indirect graphite formation in Si-poor cast irons. Exhaustive study of these conditions by means of cooling curves showed that graphitization is based on 3 phases, a eutectic crystallization, an exothermic disintegration process, and a strongly endothermic transformation, which is connected with an endothermic dissolving process. The varying sequence of these 3 processes is the reason for the different characters of the S-shaped cooling curves. Eutectic crystallization occurs from both the solid solution-graphite mixture and the solid solution-carbide mixture. The exothermic disintegration consists very likely in a precipitation of elementary C from a complex silico-carbide. The third phase, which is connected with a temperature drop of 30°-50° C., is probably due to the transformation of the α-Fe liberated in the disintegration phase, into γ-Fe and to the diffusion of part of C into the new γ-Fe. These 3 stages are discussed theoretically and thermal equilibrium calculations are made to show the correctness of the deductions and the agreement with experimental findings as revealed in the micrograms. Also, the anomalous ferrite formation in thin-walled castings occurs usually if the Si content of the α-Fe is so great that the γ-transformation is partly or entirely suppressed. 18 references. Ha (3a)

Determinations of the Viscosity of Molten Pig and Cast Iron by a Torsion Method (Bestimmung der inneren Reibung von Roh- und Gusseisen nach den Torsionsverfahren) E. DIEPSCHLAG & O. GESSNER. *Z. anorg. allgem. Chem.,* Vol. 239, Sept. 3, 1938, pp. 197-215. Critical review plus research. The existing methods for determining viscosities of liquids and of molten metals are carefully reviewed, and it is shown that a torsion viscosimeter of a type theoretically treated by Margules should be most suited for studies on molten metals. A rotation viscosimeter was designed and constructed that may be used for determining the absolute viscosities of liquids and metals at high temperatures. Measurements made on water, oils and mercury at room temperature were in excellent agreement with published results obtained by various methods. All the results obtained on molten metals, however, appear to be much higher than any previously published values, which have always indicated that the viscosities of molten metals are of the same order of magnitude as water. The values here obtained on molten Fe are 50-100 times as great, and correspond to the viscosities of heavy machine oils. Since there are no other data at present that were obtained by the torsion method, it is impossible to say whether the absolute viscosities obtained are correct as they stand or whether they are the result of an undiscovered source of experimental error. The present method seems to be sensitive, easy to use, and gives reproducible results. The viscosities of a number of pig and cast irons were determined at various temperatures above their melting points. HFK (3a)

The Effect of Treating Cast Iron with Caustic Soda. T. L. JOSEPH, F. W. SCOTT & M. TENENBAUM (Univ. Minnesota) *Metals and Alloys,* Vol. 9, Dec. 1938, pp. 329-335. This article deals with the treatment of gray Fe with caustic soda in respect to the following: Elimination of S, changes in chemical and oxide analysis, transverse tensile strength and microstructure. A method of applying caustic soda below the surface of the metal is described. A mechanical drawing of the apparatus used is included. The possibility of such a method may be of interest to blast furnace operators because there is a need for a means of applying desulphurizing agents with alkali bases so as to obtain greater contact with the metal and more complete reaction before the alkalies are volatilized. All additions were made to one ladle, which received the metal directly from the cupola spout. The end products of the chemical reactions were gases, fumes and slag. Appreciable reductions in the S content were observed, which in turn materially increased the transverse strength of test bars cast in dry sand molds. Tests showed that the efficiency of the caustic soda was decreased as the percentage of S decreased. The addition of NaOH to gray Fe had the tendency to cause the graphite flakes to become thinner and less blocky, as shown by 12 photomicrographs. CWH (3a)

Three Part Molding on Shaking and Lifting Molding Machine (Dreiteiliges Formen auf Rüttel- und Pressabhebeformmaschine) PAUL FRECH. *Giessereipraxis,* Vol. 59, Nov. 20, 1938, pp. 475-477. Description of a molding machine for a special type of casting, *viz.* cast Fe hollow bodies in which the outer and interior dimensions, *i.e.* the wall thicknesses, should be absolutely true to dimension, and the castings absolutely free of slag inclusions and pores. As the casting required 3-part molding, 3 molding plates and 3 molding machines are provided. The machines used are compressed air operated shaking molding machines, to attain uniform strength of the molds and high production capacity. The molding procedure is considered at length. GN (3a)

Control of Open Hearth Slags? *Blast Furnace Steel Plant,* Vol. 26, Oct. 1938, pp. 991-994, 1037. Description of some plant experiences with slag control. In order to determine what FeO in slag was desired, rolling results were checked against FeO, but no correlation was found. As a large part of the production was rimming steel, it was decided to concentrate on this type. Trying to control FeO by adding roll scale led to difficulties. However, investigation showed that heats high in FeO had low SiO_2 slags, those low in FeO had high SiO_2 slags, those with proper FeO had medium SiO_2 slags, and the sum of FeO, SiO_2 and CaO always was about the same. This indicated that by holding CaO constant, FeO could be changed by changing SiO_2. On heats with high FeO and C higher than desired, adding sand to slag proved to be a cheap way of lowering C and balancing up slag. When SiO_2 in slags was above 19%, many heats had high S, suggesting use of more CaO. Most of the above was determined after the heats were in the ladle. To use this information early in the heat, viscosity and pancake tests of slags were tried, but these were unsatisfactory. A rapid chemical method of determining SiO_2 in slag was developed, and the results were found to check better than the FeO determinations. Now slag samples are analyzed as soon as possible for SiO_2 and FeO. If SiO_2 is high, CaO is added. If SiO_2 is low and FeO fairly low, no additions are made for a while. If SiO_2 is low and FeO high, sand is added, provided there is plenty of C. Melters were able to come within 1% of the final SiO_2 desired most of the time. SiO_2 determination also helped with soft heats, where formerly erratic results were obtained when pig-Fe was added to raise C. Now if soft heat has low SiO_2 and high FeO, a little ferrosilicon is added before pig-Fe. If SiO_2 is high, pig goes in alone. It was decided to keep FeO high, so as to get good rimming action, which meant holding SiO_2 well below 16%. However, this required more CaO and longer time per heat, and the steel tended to be sluggish. Checking of a large number of tapping slag compositions against defects showed that about 19% SiO_2 was the optimum amount. Nevertheless, if the author [evidently a superintendent] wishes to be sure of a special heat, he still relies upon the judgment of the first helper." MS (3a)

Theory of Hydrogen Elimination During Electric Steel Making. N. CHUIKO. *Teoria i Pract. Met.,* No. 7-8, 1938, pp. 48-55. In Russian. An extended original investigation from the physical chemistry standpoint. The elimination velocity of H_2 from molten steel is directly proportional to the H_2 concentration in the metal. A study of a large number of heats shows an always present drop in H_2 content during boiling which is greater with a higher gas content. Pronounced deviation in the numerical values recorded is associated with simultaneous H_2 absorption taking place during boiling, hydrogen content in the furnace atmosphere varying between 1.83 and 26.4%. With low carbon elimination rates, H_2 absorption most strongly affect the reactions of C removal, particularly when H_2 concentration is low. When C is eliminated at a lesser rate than 0.1% per hour, H_2 is not removed. On this account, a C elimination rate of 0.2-0.3% per hour can be recommended in acid furnaces without overoxidation of the metal. H_2 content in acid steel varies between 0.001-0.00173% after melting down and between 0.00062 and 0.0008% at the end of boiling. In basic steel the content of the gas ranged from 0.002% after melting down to 0.0005% after boiling. (3a)

Teeming Temperatures. ERWIN H. WALDMAN (Andrews Steel Co.) *Steel,* Vol. 103, Nov. 21, 1938, pp. 44-45. Practical. Recommends use of optical pyrometer as a control instrument to aid in improving open-hearth practice, and gives details of procedure. Melter foreman should be the man to use the pyrometer. When heat is ready to tap, he should make the usual tests, and if heat is found ready to tap, pyrometer should be used. Before these temperature tests are made, all additions to be made in furnace should be completed. Readings should be taken of steel and slag inside of furnace and of steel stream as it flows from runner into ladle and as third ingot is being poured. Readings, furnace conditions, teeming practice, etc., are recorded and, after heats are followed through to completion, correlated so as to determine standard tapping and teeming temperatures. To secure such temperatures for every type and classification of steel made, at least 20 data temperatures should be obtained by each melter for each and every kind of steel made. A different standard temperature for a certain kind of steel may be assigned to each melter, if advisable. Use of pyrometer will insure continuity of quality and uniformity, insofar as temperature factor is concerned. MS (3a)

Electric Furnaces in European Steelworks. D. F. CAMPBELL. *Iron Steel Inst.,* Advance Copy No. 5, Oct. 1938, 14 pp. Review. Modern European practice with arc and induction furnaces is described. Electric furnaces for smelting Fe ore are briefly discussed, and steel-making furnaces described in detail. The relative merits of hydraulic and electric regulation of electrodes, fixed and removable roofs, various types of charging baskets, fixed and rotating hearths, and amorphous, graphite and Soderberg electrodes are considered. JLG (3a)

Critical Consideration of Methods Devised for Saving Coke in Cupola Melting (Kritische Betrachtung von Verfahren, die zwecks Brennstoffersparnis beim Kupolofen erdacht sind) BERNHARD OSANN. *Giessereipraxis,* Vol. 59, Oct. 23, 1938, pp. 435-438; Nov. 6, 1938, pp. 462-465. Practical. Saving of coke in cupola melting should not be overemphasized. The heat balance of a cupola is given. Coke consumption of 9% in melting is considered to be normal. Among the methods of decreasing coke consumption are: (1) Preheating the blast, a practice that dates back to 1832. The Schürmann cupola working with preheated air is described. (2) Use of cupola with water injection, still a doubtful method. (3) Melting with enriched blast, a practice that is too expensive. (4) Melting with dried air (Gayley). (5) Use of cupola with blast in the upper part of the cupola (Poumay method), said to be of doubtful value. (6) Utilization of waste gas heat to generate steam and hot water. (7) Use of Ibbrügger cupola with utilization of waste gases for melting purposes (this method has been discarded). (8) Use of cupolas with oil, powdered coal and gas firing, which are all uneconomical. (9) Methods of treating the coke with lime or clay (Corsalli and Magyar method, no longer in use). (10) Use of cupola with electric heating. All of these methods are critically considered Most of them are unsuccessful. 18 references. GN (3a)

The Fluidity of Iron-carbon and Other Iron Alloys. Part A.—The Fluidity of Alloy Steels. J. H. ANDREW, G. T. C. BOTTOMLEY, W. R. MADDOCKS & R. T. PERCIVAL. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 5-32. Original research. Fluidity tests carried out with the standard spiral mold described in the Second Report were extended to Fe-C alloys containing varying amounts of Si, Cu, Cr and Ni, respectively. In order to correlate the fluidity numbers with the liquidus and solidus ranges, freezing- and melting-point determinations were made on all alloys dealt with. The system of plotting the fluidity values at temperatures 50° C. above the liquidus curve was adopted, but a better system is to plot the temperature at which the fluidity is 12 in. against the composition. The curves derived in this manner follow the liquidus curves very closely. It is evident from the results that temperature is the all-important factor with respect to fluidity, composition in itself playing a minor part. For previous work, see also *Metals and Alloys,* Vol. 8, June 1937, p. MA 344 L/2. JLG (3a)

Duplexing Malleable Cast Iron. GEORGE A. SCHUMACHER (Albion Malleable Iron Co.) *Foundry,* Vol. 66, Oct. 1938, pp. 22-24, 88, 90. Practical description of the metallurgical advances made in the last 50 yrs. by the Albion Malleable Iron Co., with special reference to present day practice. Duplex melting is done in a cupola and a pulverized-coal-fired air furnace. Twenty tons of metallurgically desirable white Fe/hr. can be produced at 2900° F. Charging is done mechanically. Cupola Fe is analyzed for total C, Mn and S every ½ hr. Molding is done by mechanized line molding and heap or bench type. Molding sand moisture content ranges from 4 to 4½%, permeability 65, green compression strength 8 lb./in.², clay content 3-5% and average grain fineries 65. High grade washed round grain silica sand is used for core mixtures. Batch type annealing ovens are used with a capacity of 35 tons of castings. Annealing cycle consists of about 24-30 hrs. of preheating; 28-32 hrs. of holding at 1600° F. and 66 hrs. of cooling. VSP (3a)

Development of the Dendritic Structure of Stainless Chromium Steels (Die Ausbildung des Primärgefuges bei nichtrostenden chromstählen) H. SIEGEL. *Stahl u. Eisen,* Vol. 58, Nov. 3, 1938, pp. 1218-1225. Original research. Ingots of low C 14.5% and 17% Cr steel of 250 mm.² cross-section, weighing 400 kg., were cast and transverse sections deep-etched to reveal the dendritic structure. This was then related to the inclusion content and "temperature value" as judged by the heat input; the variables considered were: Nuclei number, crystallization rate, degree of superheat and heat gradient at the solidification surface. In the examples given the dendritic structure (depth of columnar zone and fineness of crystals in interior granular zone) could be consistently explained on the basis of Tammann's laws of crystallization. SE (3a)

Inclusions and Gases in Steel. F. F. FRANKLIN. *Blast Furnace Steel Plant,* Vol. 26, Nov. 1938, pp. 1081-1084, 1096. *Heat Treating Forging,* Vol. 24, Nov. 1938, pp. 543-546, 553. Review of literature since 1936 on effects, methods of determination, types, occurrences, distribution, and control. In controlling inclusions and gases, excess deoxidizer must be avoided. Among the practices recently introduced for reducing gas or inclusion content of steel are (a) for high frequency melting, addition of 0.2-0.4% Fe-Mn and an acid slag before melting, followed by double removal of FeO-rich slag, replacing slag with a lime-silica mixture during refining, cutting off current before adding the last deoxidizer, then cutting it in again just before tapping; and (b) for open hearth practice, either boiling for 2½-3 hrs. (no more nor less), or agitation of the bath, *e.g.* by bubbling a neutral gas through it. The Perrin process and the use of alkali slags for removing inclusions from cast Fe are also discussed. MS (3a)

At IOWA STATE

"In 1924, we purchased a 35KVA Ajax-Northrup High Frequency converter for use in the production of alloys for our research in metallography. For the most part, our work has involved studies on the graphitization of white cast iron.

"It is possible with the converter to produce the desired compositions quickly and easily. The simplicity of the alloy forming process has made it possible for the research workers to cover their metallographic problems thoroughly in a relatively short time.

"The induction furnace has been a great aid in the preparation of magnesium oxide crucibles for use in making high purity alloys. Some of our work has involved the heating of metals to high temperatures in vacuo or in inert or controlled atmospheres; the induction furnace is ideal for this kind of operation.

"Our Ajax-Northrup unit, which is one of the earlier models is still in good working condition.

"A number of Doctor's dissertations have been written here on work that has involved the use of our induction furnace. Some of these works have been published and are as follows:

Jennings, W. H., Pennington, W. A. The determination of the rates of graphitization at 925 C. in tungsten—manganese white cast iron. Trans. Am. Soc. Metals 22, 751-65 (1934).

Hayes, Anson, Brodie, G. H., and Jennings, W. H. Heat of formation of cementite as electrolyzed from pure iron carbon alloy of eutectoid structure and composition. Amer. Soc. for Steel Treat., Trans. 10:615-30 (1926).

Jennings, W. H., and Henderson, E. L. Effect of molybdenum on graphitization of white cast iron. Metals and Alloys, 2:223-226 (1931).

Lykken, Louis The influence of copper on the graphitization behavior of white cast iron. Iowa State College Jour. of Sci. 8:207-210 (1933).

Hayes, Anson, and Wakefield, H. U. The carbon content of pearlite in iron-carbon alloys containing one per cent silicon. Amer. Soc. for Steel Treat., Trans. 10:214-221 (1926)."

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AJ-1-E

Investigations on Transformations in Basic Open Hearth Slags During Melting, in Particular the Behavior of Lime (Untersuchungen über Umsetzungen in basischen Siemens-Martin-Schlacken während des Schmelz, verlaufes, insbesondere über das Verhalten des Kalkes) GOTTFRIED PRIEUR. *Doctor's Thesis, Tech. Hochschule Breslau.* 44 pp. The melting course of 9 experimental basic open hearth heats made with (1) high lime content in burden, (2) high limestone content and simultaneously high Si content in scrap used, or (3) low limestone content and high P content in slag. In all slag samples taken, the chemically unbound CaO content, forming a special phase, was determined by the method of Diepschlag-Matting. The investigation studied in particular the relations between (1) free CaO and burden composition, (2) CaO and the other slag oxides, (3) CaO and the acidic constituents of the slag, (4) the dissolution of FeO and CaO in the slag and the concentration of Mn and P in the heat. From the CaO concentrations found in the slags of the various heats, the course of Ca dissolution in the slag could be established. The chemical transformations in bath and slag attain an equilibrium state at a rather early stage. The location of the equilibrium is clearly related to the concentration of the slag components, and from these the course of the bath reactions can be predicted. 8 references. GN (3a)

Fluidity-temperature Relations of Cast Steels of Various Compositions. R. J. SARJANT & T. H. MIDDLEHAM. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 45-60. Original research. The Ruff fluidity tester was used in the laboratory for making fluidity tests under closely controlled conditions on various steels. It was also used for some plant trials, and as a plant instrument it seemed to be practicable. There was a very definite correlation between temperature and fluidity and results were closely repeatable. Swedish charcoal Fe had greater fluidity than Armco Fe, even though the analyses were almost alike. For C steels the general form of the fluidity curves given in the Second Report was confirmed, with the exception of some divergence in the fluidity-composition curves for specified degrees of superheat above the liquidus. Additions of Al (up to 0.3%), of Si (up to 1%), and Mn (up to 1%) confer increased fluidity on low-C steel. The increased fluidity possibly results from increased deoxidation. Additions of Cu (up to 2% produce only a slight increase in fluidity, which in the case of a 2% Cu content is not increased by further additions of Si (0.5%) and Mn (0.5%). JLG (3a)

First Report of the Moulding Materials Sub-committee. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 87-200. Original research. Among the subjects considered are: 1. Methods of testing molding sands for steel foundry use. 2. Relation of the "bond" in naturally bonded and synthetically bonded sands to "stripping" and "burning on," including the properties of reclaimed sand. 3. Effect of washes on stripping and the casting skin. 4. Investigation of the behavior of synthetic bonds with clean high-silica sand, weak clay-bonded sand, and influence of grain characteristics on bonding. 5. Effect of pressure on the sintering and softening of molding sands. 6. Methods for the preparation and reclamation of molding materials. 7. Investigation of the properties of core bonds. 8. Volume changes in molding sands and "compos" from 0° to 1400° C., including the effect of composition, grading, and ramming density. 9. Effect of thermal conductivity of the mold on the casting. JLG (3a)

Heavy Oil Burning and Its Control. A. J. FISHER. *Iron Steel Engr.,* Vol. 15, Dec. 1938, pp. 22-47. Practical. Modern methods of fuel engineering have made it possible to locate steel plants near the ore field and the steel consuming centers rather than near the coal fields. The first period in burning fuel oil, hand-controlled period, was from 1861 to 1932. The period 1932 to date may be called the automatic controlled period of fuel oil burning. Temperature and pressure recorder controllers, fuel oil control, oil burners and furnaces are combined to a unified oil system to obtain specific results. Furnace design is of utmost importance for an oil burning system. Various regulating and controlling devices, oil burners and oil conditioning systems are described. Combustion data and heat balance calculations are given. CBJ (3a)

Processing of a Multi-blade Water Turbine Wheel of One Piece of Cast Iron (Herstellung eines mehrflügeligen Wasserturbinenlaufrades aus einem Stück in Gusseisen) F. PASCHKE. *Giessereipraxis,* Vol. 59, Sept. 25, 1938, pp. 396-400. Descriptive. After a historical survey of making such heavy intricate castings of one piece, sweep molding applied to the particular case considered is described. Runners made by means of cores were not as successful as sweep-molded ones. The blade wall thicknesses were true to dimension; at least the differences observed were negligible. The processing time was thus considerably shortened and the production costs were essentially decreased. GN (3a)

The Development of the Open-hearth Steelmaking Processes in Recent Years in the United States of America. L. F. REINARTZ (Am. Rolling Mill Co.) *J. Iron Steel Inst.,* Advance Copy No. 12, Oct. 1938, 47 pp. Up-to-date review. A comprehensive and frank discussion of open-hearth equipment and practices in the United States. The annual capacity is now over 71,000,000 gross tons of ingots and castings. The basic open-hearth process has far outstripped in production its acid open-hearth or Bessemer rivals because of its greater flexibility from the standpoint of Fe analyses requirements, and because the basic process can use great varieties of Fe and steel scrap. JLG (3a)

Investigation of the Melting Process in a 300-ton Open Hearth Furnace. L. VLADIMIROV & G. BESKHMELNITSKAYA. *Stal,* Vol. 8, May 1938, pp. 35-41. In Russian. Practical. A 150-ton furnace that was rebuilt to hold 300 tons with a deep metal bath is compared with a 150-ton furnace operating on a 190-ton charge as follows: Average length of heat 14:54 hrs., *vs.* 12:58 hrs.; average daily production 482 tons *vs.* 360 tons; daily production per m.^{2} hearth area 6.58 tons *vs.* 5.15 tons. Maximum production is obtained if the metal contains 1.1% C on melting, as this permits an intensive boil during the oxidation period. HWR (3a)

Casting Automotive Parts—Steel and Gray Iron Casting Methods at Ford Motor Co. of Canada, Ltd. *Can. Metals Met. Inds.,* Vol. 1, Nov. 1938, pp. 299-302. Descriptive. The melting equipment consists of two 12,000-lb. Swindell electric furnaces, one 8,000-lb. Pittsburgh electric furnace and two 10,000-lb. Brackelsberg furnaces. The metallurgical and technical methods employed in the production of the various types of castings made are described, with particular attention to the casting of crankshafts, steel hubs, camshafts and push rods. WHB (3a)

Works Results Using the Ruff Fluidity Test. T. R. WALKER. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 35-43. Original research. The Ruff fluidity test was used at 2 steel foundries, and the results considered in reference to temperature of the steel as determined by an optical pyrometer and reports of the men pouring the steel. There was general agreement between fluidity and temperature and between fluidity and the workers observation on pouring. JLG (3a)

American Electric-furnace Practice. W. M. FARNSWORTH & E. R. JOHNSON (Republic Steel Corp.) *Iron Steel Inst.,* Advance Copy No. 7, Oct. 1938, 15 pp. Descriptive. Electric arc and induction furnace equipment and operation at the Republic plant is described in detail. Particular attention is given to raw materials used and the various modes of procedure in normal alloy-steel practice, stainless-steel practice and the duplex practice for making stainless steel. Logs of furnace heats are given. JLG (3a)

Melting in the Cupola (Das Schmelzen im Kupolofen) H. JUNGBLUTH & H. KORSCHAN. *Arch. Eisenhüttenw.,* Vol. 12, Oct. 1938, pp. 167-173. Practical. It is suggested that the air drawn into the cupola is burned to CO_2 at the glow zone near the tuyeres. The extent of the glow zone depends, not on the amount of coke, but on the amount of air. The increase in output with constant coke addition and increased air flow is due to the greater glow zone, which enables faster melt down of the charge. With constant air flow and increasing coke charge, coke which is not in the glow zone reduces CO_2 formed in the glow zone to CO. Under these conditions, the coke ratio is excessive and the efficiency is lower. This theory appears to be in accord with thermal data. SE (3a)

Foundry Pig Iron from Iron-poor German Ores and Its Use in the Foundry (Giessereiroheisen aus eisenarmen deutschen Erzen und seine Verwendung in der Giesserei) M. PASCHKE & C. PFANNENSCHMIDT. *Giesserei,* Vol. 25, Oct. 24, 1938, pp. 539-546. Practical. The new method of Paschke-Peetz for melting Fe-poor ores in the blast-furnace with a slag basicity (CaO/SiO_2) of only 0.8 against 1.25 in the usual process and desulphurization in a subsequent process has also influenced foundry practice in Germany to a certain extent. Mixtures of pig Fe from this acid process with scrap, ferro silicon, and other material to produce castings of desired quality are discussed and several examples are given with their physical properties. 12 references. Ha (3a)

Casting Properties of Metals (Les Propriétés de Fonderie du Métal et de la Fonte en Particulier, Conséquences Pratiques) MARCEL DUDOUET. *Bull. l'association tech. fonderie,* Vol. 12, Aug. 1938, pp. 172-177. A discussion of fluidity, shrinkage, cracks and gas pockets. Considers the effects of casting design, melting method and chemical composition on defects in cast Fe. WHS (3a)

3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Moulding Materials. Practice in Non-ferrous Foundries. FRANCIS W. ROWE. *Metal Ind., London,* Vol. 53, Nov. 11, 1938, pp. 471-473. The most common material for molds for non-ferrous alloys is, and always will be, natural siliceous sands. In recent years some use has been made of silica sands with additions of bonding materials. Because the thermal conductivity of the mold material influences the speed of cooling, the sand mold is at a distinct disadvantage as compared with the metal mold. The use of chills in sand molds do not give results equal to those obtained in metal molds. Centrifugal casting automatically compensates for liquid shrinkage, and produces finer grain castings. The difference in the physical properties of a small and large centrifugal casting is not as great as in a sand cast. The use of the green sand mold results in sharper castings, smoother skin, less flash and lower fettling cost. The advantages of a properly made synthetic sand are: Permeability is greater, and much greater strength is obtained. The cement-sand or Randupson process is rapidly coming to the fore. Properly made cement-sand molds have a much higher permeability than other types of molds, and possess extraordinary strength, even in very large masses. The basis is a sand of about 97% silica. This is mixed with 4-13% cement with water to ensure primary hydration of the cement only. While being rammed the molds are reinforced with Fe rods. The molds are made at a time saving of 20-60%, and require 24-72 hrs. to dry. The disadvantages of the process are: The sand has no green bond strength, the time required for air setting is usually 48 hrs., the sand must be used within 3-5 hrs. and all sand must go through a mixing plant both originally and for reconditioning. These are far outweighed by the advantages in overall labor cost saving, and technical advantages due to high permeability, great mechanical strength and freedom from scaling. It is equally adaptable to work usually done in box parts as well as work struck up in loam. It is not recommended for work usually done in green sand, such as small parts, but for all work usually done in dry sand or loam. RWB (3b)

The Relation between Casting Conditions and the Resistance of Metals and Alloys to High Pressures (Dichtigkeit von Metallen und Legierungen gegenüber hohen Drucken in Abhangigkeit von deren Gussbedingungen) G. WELTER & J. MIKOLAJCZYK. *Metallwirtschaft,* Nov. 11, 1938, pp. 1187-1191. Research. An apparatus is described wherein samples can be subjected to liquid pressures of 1000 atm. and gas pressures of 150 atm. Melting and casting conditions, such as flux, pouring temperature, size of section and location of specimen, were investigated for Al alloys. Thinner-walled sections are more dense as a rule. The same holds for Mg base alloys. Materials that exhibited no porosity under 350-400 atm. liquid pressure will show no porosity under 150 atm. gas pressure. Materials not permeable to liquids at 400 atm. will generally not leak up to pressures of 1000 atm. A Mg alloy and a Zn alloy were also briefly studied. GA (3b)

Effect of Casting Defects on the Strength of Light Metal Castings (Einfluss von Gussfehlern auf die Festigkeit bei Leichtmetallgusstücken) F. BOLLENRATH & E. SCHIEDT. *Luftfahrtforschung.*, Vol. 15, Oct. 10, 1938, pp. 511-516. Original research. Some defective castings of airplane parts made of Al and Mg alloys (analyses given) were tested to destruction under static and dynamic loads. To appraise the importance of defects in castings, one must know the regions of maximum stress in the member. Differences in structural homogeneity and wall thickness were found to exert a greater influence on the service life than blow holes, pipes and gas pockets of 3-5 mm. diam., unless the latter are located directly in the regions of maximum stress. In this case, a hole of 2 mm. diam., for instance, materially reduced the dynamic strength of an angle girder of Elektron. Changes of cross-sectional area must be free of defects. Otherwise, casting defects of 4-5 mm. diam. are admissible. Cracks and oxide skins perpendicular to the surface must be absent. Larger blow-holes of more than 5 mm. diam. and spongy castings should be rejected. Coupon tensile tests are no guarantee of the usefulness of a casting. The tests should be carried out on the casting itself, under conditions closely simulating actual service conditions. EF (3b)

A New Die Casting Method (Ein neues Kokillengiessverfahren) *Giessereipraxis*, Vol. 59, Nov. 20, 1938, pp. 481-482. Description of a new French method for making die castings of Cu alloys. Before each single casting, the heated die is immersed in a water bath in which insulating substances are suspended. The die is thus covered with a thin uniform insulating coating. Graphite, clay, Al_2O_3, ZnO, talcum, etc., may be applied as coating substances. Absolutely clean, smooth castings of high finish are claimed to be obtainable by this method, so that any subsequent treatment, such as pickling, is not required. GN (3b)

The Hazard of Sodium Metal (Ueber die Gefährlidikeit von Natriummetall) *Chem. Ztg.*, Vol. 62, Nov. 30, 1938, p. 860. Practical. Na used for refining Silumin, also reduces its grain size. About 80 g. of Na are used for a 100 kg. bath of alloy. Na is dried from kerosene by means of paper, then wrapped into Al foil and hammered to drive out the air. The package is then put into the bath and kept under the surface of the melt. Extreme caution is necessary during cutting off and handling of the metal to keep it away from moisture. Special regulations for shipment, storage and handling were issued in Germany. RPS (3b)

Influence of Moisture Content of Moulding Sand on Strength Properties of Cast Aluminium Test Bars. C. GIERDZIEJEWSKI. *Foundry Trade J.*, Vol. 59, Oct. 20, 1938, pp. 289-292. Descriptive. Test pieces cast from metal melted in identical conditions show differences in properties. These differences are small when testing chill-cast samples, but relatively important with sand-cast samples. According to Lepp (Internatl. Foundry Congress, Prague, 1933) variations of strength properties depend on the moisture content of the sand used for either molds or cores. The steam produced when pouring molten metal into the molds reacts with the metal, forming oxides. At certain conditions pockets may be formed in the molds that affect their heat conductivity, favoring local increase in temperature and pressure. Lepp's conclusions were confirmed by tests on some of the bronzes. The author also studied the effect of moisture content on the strength of test bars cast from different Al alloys. All test bars were made with one molding sand, with the permeability and strength properties controlled, leaving moisture content as the only variable. 6% Cu-Al, 10% Si-Al and Hiduminium RR50 (approximate analysis: Cu 1.40; Si 2.00; Fe 1.13; Ni 0.90; Mg 0.10; Ti 0.13) alloys were used in this test. Six specimens were cast simultaneously in molds having moisture contents of 0, 3, 5, 7 and 9%, and in addition, one chill sample was cast. After casting, the chill sample was taken out of the mold, while the sand-cast samples were left in the molds for 40 min. In 6% Cu-Al alloys, increase of moisture produced a grain refinement and increased porosity. The tests on 10% Si-Al alloy revealed that increase in the moisture caused an increase of tensile strength and a decrease of elongation, but had no influence on Brinell hardness. Test-bars cast in chill molds showed highest tensile strength but a lower elongation. For Hiduminium alloys there was some increase in tensile strength and elongation with an increase of moisture content. In all cases examined, an increase in the moisture content of the mold produced a refinement of the structure and increased porosity of the castings. AIK (3b)

Sand Cast Manganese Bronze. *Metal Ind., London*, Vol. 53, Oct. 7, 1938, pp. 347-348. Practical. This report is divided into 5 sections dealing with, molding, melting and pouring, finishing, heat treatment, and the cause and prevention of defects. Considerable latitude is permitted in the grain size of the sand used for this alloy. A sand of about AFA No. 1 or 2 grain size, D to F clay content of 5-20% and moisture content of 5-6% is suggested for this alloy. With this sand no facing is needed. The drossing tendency of the alloy makes special gating precautions necessary. Best castings are obtained by filling the mold by displacement. The alloy permits strong cores and silica sand with a good grade of core oil is suggested. All types of melting furnaces are used. Superheating is unnecessary and should be avoided. Unprotected thermocouples may be used but covered tips are finding increased favor. No deoxidizers are required, but fluxes are useful to retard vaporization of the Zn. The maximum temperature in melting should be no higher than that necessary to pour satisfactory castings in the range 1775°-1925° F. Gates and risers may be removed with a band saw operated at a speed of 120-130 ft. min. For cleaning, the usual methods of sand blasting, wire brushing, pickling, and water tumbling are followed. Only very slight changes in physical properties are produced by the usual methods of heat treatment. Gas inclusions may be avoided by preventing overheating and using a nearly neutral atmosphere. By covering with charcoal and using a neutral or slightly reducing atmosphere, oxidation may be avoided. In casting, misruns and cold shuts indicate too low a pouring temperature. Molding sand defects and preventions are discussed. Pb is the chief undesirable impurity in Mn-bronze; in a large casting a maximum of 0.40% Pb is permissible. For castings unlikely to meet severe stresses, an upper limit of 0.50% Pb is not excessive. RWG (3b)

Non-ferrous Foundry Practice. XII—The Production of Some Special Castings in 88-10-2 Gunmetal. J. LAING & R. T. ROLFE. *Metal Ind., London*, Vol. 53, Oct. 14, 1938, pp. 367-369. Practical. The casting of an eccentric ring (1 in. out of true circle) in a loam mold with plain type strickle boards is described. The complete mold was stove dried and the faces washed with a mixture of plumbago and talc, to which a little core gum and clay water was added and then returned to the stove to be dried. When the runner and riser bushes were made up, the job was cast in the usual manner. The various stages in the manufacture of a 27½ in. bottom half centrifugal main circulating pump casing are shown. The pattern was split on a flat plane and built up in skeleton fashion. 2 large down-gates were used, each connected to the joint flange by 4 in-gates; one gate led into the flange of the discharge branch. When the half patterns were withdrawn the mold was cleaned and finished to shape, with the loose flanges and brackets all left in position. After clay thickening, the suction branch was covered with plastic loam and the core Fe inserted; pieces of dried loam were pressed into the plastic loam. Cinders were next rammed into the center of the core, the check rings, cut water and loose pieces placed, the upper face filled with loam and the core dried with firebuckets. The completion of the half body core followed the same line. Next, the clay thickened pieces were cleaned out, the suction branch core removed and the mold dried. The mold was then assembled and dressed. It is essential to test the metal thicknesses all over the surface of the mold, and between the suction branch and body case, for a local thinness or even a misrun may occur. In the example given, the weight of metal in the ladle was about 2850 lbs., temperature 1,225° C. and time of pouring 41 secs. RWB (3b)

Non-ferrous Foundry Practice. XIII. Moulding Practice for Phosphor-Bronze. J. LAING & R. T. ROLFE. *Metal Ind., London*, Vol. 53, Nov. 4, 1938, pp. 443-445. Aside from one or two important characteristics, due to the presence of P, production methods for P-bronze are very similar to those for gunmetal. When design and volume permit, chilled castings should be used for this range of alloys. Chilling increases hardness, proof stress and ultimate stress figures, but reduces ductility in a corresponding degree. As Sn and P contents increase, the effect of chilling becomes more pronounced. Annealing at 700°-750° C. will often benefit the ductility. Where design prevents the use of chill casting, local chills are often necessary. Except for very small castings it is inadvisable to use the green sand method. If chill casting is not used because of penetration, the dry sand method should be used; green sand castings are definitely inferior. When uniform soundness is essential, gating either from or near the top of the casting is generally advisable. The high fluidity permits top-pouring at low temperatures in sand molds. To produce hydraulically sound castings, the use of chills at heavy sections is usually necessary, as well as keeping runners away from heavy portions. When chills are used, the metal must not strike directly on them. For dry sand work, chills should be cleaned and given a thin coat of oil. The temperature of the mold should not exceed 100° C. The use of risers should be restricted as much as possible. Small castings, poured at the correct temperature, will not require a riser if gated near the top. Feeding heads are generally unnecessary. For low P content, gunmetal practice with runner bushes is suitable. For high P content, the bushes must be so designed that they can be kept choked with metal during pouring. For small work, the area of the down gate should be reduced. Of the nonferrous alloys in common use, the pouring temperatures of the P-bronzes are about the most critical. The range of composition is very wide, and the optimum casting temperature may be below 1000° C. for the Cu-Pb-Sn-P alloys, or as high as 1100°-1150° C. for the low P-Cu-Sn alloys. The 10% Pb alloy must be stirred before pouring, and melting practice for gunmetal is followed. Large quantities of gear blanks are now cast centrifugally, this process not only giving a denser structure, but also permitting the selective chilling of one or more faces. RWB (3b)

4·WORKING

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER AND H. W. GRAHAM, SECTION EDITORS

New Applications for Press Work. II. New Applications Possible by Increased Depth of Draw. J. D. JEVONS. *Metal Ind., London,* Vol. 53, Nov. 11, 1938, pp. 467-470. Practical. Extension in this field of application may be attributed to (1) the production of new shapes which can be produced only by deep-drawing or pressing, (2) the replacement of parts which, prior to the postulated increase in depth in draw, could be made more satisfactorily or cheaper by other methods, and (3) the elimination of interstage annealing, with consequent reduction in the cost of pressed and deep drawn articles. The bodies and mud guards of modern automobiles offer an excellent illustration as to how increased depth of draw or pressing leads to an increased field of application. Exact contour of auto head light shells has no practical significance, but the shape of the reflector is important. This introduces another aspect, namely, the value of increased accuracy, as distinct from depth. When very close conformity in dimension is required, it is customary to give the article one or more final squeezing operations between dies, a process akin to "coining" and needing very robust presses and careful tool setting. Accurate "sizing" by finishing operation enables final rectification in dimensions. In deep drawing, improvements in the quality of the metal itself, drawing technique, tools, lubricant and interstage annealing have all contributed to the more severe drawings now being used. Brass tubes deep drawn from flat blanks are cheaper and have a greater uniformity of wall thickness than tubes drawn from cast tubes or pierced billets. The interstage anneal adds to the cost and slows up the process. With constant improvements from all viewpoints, more and more drawn and pressed parts are being made almost eliminating this phase but there is clearly a limit to the amount of plastic deformation without an anneal. The value of pressing in thick sheets is well illustrated in the pressed steel auto-wheel, which is a growing application. For Part I see *Metals and Alloys,* Vol. 10, Feb. 1939, p. MA 88 L/3.
RWB (D-4)

Recent Developments in Hot Rolling Mill Practice (Varmvalsverkens utveckling under senare tid) GUNNAR WALLQUIST. *Jernkontorets Ann.,* Vol. 122, No. 7, 1938, pp. 265-376. After an historical introduction, recent developments and improvements in rolling mill practice are discussed, including ovens, heating pits, roller constructions, driving mechanisms for operating the units, and the mechanical and chemical surface treatment of the finished stock. Furnaces used for heating the product are described, such as the automatic gas fired furnace, the Swedish coal tower furnace, and various recuperative devices. In roller construction, the greatest development has been in ball and roller bearings. Advantages and defects of various types of construction are pointed out. Data are presented on Swedish practice with respect to feeding devices. Developments in the roll itself are discussed with reference to the rolling of sheet from ingots; the rolling of bars, beams and heavy profile stock; the rolling of rods, wire, bands, heavy, medium and thin steel plate. An account is also given of construction and production factors affecting the process. Detailed data are given on processes for treating the surface of the finished stock.
HCD (E-4)

The Honing of Cylinder Bores (Das Honen von Zylinderbohrungen) RICHARD KOCH. *Automobiltech. Z.,* Vol. 41, Nov. 10, 1938, pp. 562-563. Practical. All machining operations cause structural changes in the surface of the material and leave fibers that tend to attack piston rings. Inside grinding does not entirely solve the problem. Smoothing by hard rolls has the disadvantage of not removing material from high points. Honing, however, is a method of solving this problem. It consists of a combination of rotating and lengthwise movements with side pressure exerted by a honestone. All Fe alloys and steels of any hardness can be honed. Except for the harder brasses, non-ferrous metals cannot be honed. Applications of honing and machines, therefore, are described. Cooling media are: Kerosene or fish oil, or a mixture of paraffine oil for cast Fe and mild steel; lubricating oil for hardened parts; water or no cooling medium for brass. The operation is described.
RPS (G-4)

The Deformation of Crystalline Aggregates by Rolling and Drawing (Die Verformung von Kristallhaufwerken beim Walzen und Ziehen) HERMANN UNCKEL. *Z. Metallkunde,* Vol. 30, Aug. 1938, pp. 252-258. Experimental. The mode of deformation of homogeneous and 2-phase alloys was observed during rolling, drawing and elongation by measuring the changes in dimensions of a grid scratched onto selected surfaces. Orientations of individual grains were determined in many cases. Irregularities of deformation resulting from differences of orientation were shown to be much less in fine than in coarse-grained material, less pronounced in drawing than in rolling, and greatest with uniaxial extension. Nevertheless, the transition from one grain to another was always gradual, with no sharp offsets at the grain boundaries. GD (E-4)

Some Notes on Forge Practice. J. H. HURST. *Metal Treatment,* Vol. 4, Autumn 1938, pp. 135-136. Practical. Circular porter bars, each suited for a particular size of round-headed ingots, are considered more satisfactory than any universal porter bar with set-screws or liners. Vertical light steel cylinders are less cumbrous than wooden blocks as supports while adjusting the bar. Wheels are preferred to flanged rollers for the hearths of bogie type furnaces. Reference is made to a method of changing press tools rapidly.
JCC (D-4)

4a. Ferrous

Structure of Iron after Compression. CHARLES S. BARRETT (Carnegie Inst. Tech.) *Metals Tech.,* Vol. 5, Oct. 1938, T.P. No. 977, 29 pp. Original research. A method of compressing specimens by rolling them successively in many different directions permitted deformation up to the limit set by the capacity of the material to flow without fracture. This and more conventional means of compression were applied to α Fe, and the results were analyzed by a special optical method, as well as by standard X-ray methods. Single crystals or individual grains of α Fe do not, in general, seek a single orientation during deformation by compression. A crystal initially having [100] near the compression axis will end as a distorted crystal with [100] parallel to the axis; while one starting with [111] near the axis will end as a distorted crystal with [111] parallel to the axis; all others cease to be single crystals and produce the structure known in the literature as deformation bands, etch bands or X-bands. The crystalline material in the bands rotates progressively as deformation continues, in a direct manner so as to bring [111] in one band and [100] in another band in positions parallel to the axis. The fraction of a crystal possessing each orientation depends upon the initial orientation. This mechanism is responsible for the compression texture of polycrystalline Fe, which was redetermined and found to be a double fiber texture with [111] and [100] parallel to the compression axis. Slip occurs on a considerable number of slip systems to produce these effects. Deformation bands have probably introduced errors in slip-plane determinations in Fe of other investigators. JLG (E-4a)

Modern Rolling-mill Practice in America (Exclusive of Continuous Strip and Sheet Mills) QUINCY BENT (Bethlehem Steel Co.) *Iron Steel Inst.,* Advance Copy No. 2, Oct. 1938, 62 pp. Descriptive. Methods and mills developed for the rolling of steel to finished products as practiced in the rolling mills of the United States are described. The first part of the paper is a synopsis of the subject, which gives a brief description of mills and practices. The appendix, forming the second part, gives more complete data on the mills and practices.
JLG (E-4a)

The Development of Continuous Strip Mills. D. EPPELSHEIMER (Am. Rolling Mill Co.) *Iron Steel Inst.,* Advance Copy No. 6, Oct. 1938, 12 pp. Review. A brief historical review of the rolling of sheets as well as the previous unsuccessful attempts to roll sheets in continuous mills is given. The fundamental requirements and means for the discovery and the subsequent application of continuous strip rolling are fully explained in detail.
JLG (E-4a)

Twisted Bars for Strength. *Steel,* Vol. 103, Oct. 24, 1938, pp. 40-42. Descriptive. "Isteg" steel concrete reinforcing bars, developed in Austria, are now being produced by Wickwire Spencer Steel Co., Buffalo, N. Y. The bar is fabricated by cold twisting together and stretching 2 rods in specially designed machinery that make 2 bars at a time. When made of ordinary structural billet steel, the product has a minimum yield-point of 50,000 lbs./in.^{2} When made of intermediate grade billet steel, minimum yield-point of 60,000 lbs./in.^{2} is obtained. An increase of 50% in allowable stresses is permitted, thus reducing necessary weight of tension reinforcing steel by about 33⅓%. Process removes mill scale, resulting in an efficient bond with concrete. Laboratory tests at Columbia University of Isteg, plain round and deformed bars showed an average of 47.2% increase in yield strength for the twisted bar. Reinforced-concrete beams 12 x 12 in. in cross-section and 9 ft. in span were loaded at the ⅓ points with equal loads. Maximum observed steel stress before failure in beams with respective types of reinforcement averaged 34,625 lbs./in.^{2} for plain round bars, 35,762 lbs./in.^{2} for deformed bars and 59,162 lbs./in.^{2} for Isteg bars. Tests on T-beams showed 48% higher efficiency of Isteg bars as to ultimate beam strength. "Pull-out" tests indicated Isteg bars have a higher total value of bond resistance.

MS (D-4a)

Factors Affecting Red-shortness. FRANK G. NORRIS. *J. Iron Steel Inst.,* Advance Copy No. 10, Oct. 1938, 15 pp. Original research. Samples from 4 open-hearth heats were forged into ½-in. square bars, which were sampled for chemical analysis and tested for red shortness by bending over an anvil while in the red-short range. If the ratio (MnO + 0.048)/(S + 0.130) [in which Mn, S and O are the percentages by weight of Mn, S and total O] is below 3.30, the sample is red short. Samples from previous investigations show that a definite value of this ratio can be established for any one investigation, above which no sample is red short and below which all are. If worked in the red-short range as soon as this temperature range is reached after solidification, a sample with a ratio as high as 6.46 is red short. In the range 6.46-3.30, the cooling conditions affect the red shortness. Independent evidence indicates that the cooling conditions affect the amount of Fe or Mn sulfide. JLG (D-4a)

The Applicability of Magnesium Alloy (Elektron) Dies (Die Verwendbarkeit von Elektron-Gesenken) B. PREUSS. *Metallwirtschaft,* Vol. 17, Sept. 2, 1938, pp. 932-934. Practical. Briefly discusses the use of Mg alloy dies for the forming of steel automobile fenders. The higher initial cost of these dies is offset by lower handling and tooling costs. The author is rather vague about the life of these dies but indicates that the ease with which these dies can be lined up will help to lead to longer die life. GA (D-4a)

4b. Non-Ferrous

Plastic Deformation and Subsequent Recrystallization of Single Crystals of Alpha Brass. M. R. PICKUS & C. H. MATHEWSON (Yale Univ.) *Metals Tech.,* Vol. 5, Dec. 1938, T.P. 989, 21 pp. Original research. Rectangular parallelepipedal specimens were cut from single crystals of α brass so that they had definite crystallographic relationships. The accuracy of these relationships was determined by X-ray methods. The recrystallization process subsequent to various degrees of plane parallelepipedal compression was investigated. Results indicated that, for intermediate degrees of deformation, single crystals require a higher temperature to effect recrystallization, and recrystallize over a wider range of temperature than does polycrystalline material. For reductions in thickness of 60% or more, the recrystallization temperature appears to be independent of the orientation of the single crystals; in fact, practically no difference was observed between single crystal and polycrystalline specimens. An X-ray study of the orientation changes accompanying deformation was made. The results proved definitely that the orientation (1-10), [112] is significant for single crystals, as with polycrystalline material, and suggests that the development of textures is probably due to similar mechanism.

JLG (E-4b)

A Comparison of the Extrusion Properties of Some Aluminum Alloys. C. E. PEARSON. *J. Inst. Metals,* Vol. 64, 1938, Advance Copy No. 817, 12 pp. Original research. A comparison was made of the behavior during extrusion of Al and its alloys with 1.5, 2.5 and 5.0% Cu, 1.25% Cu plus 10% Zn, and 5% Zn. The pressures required for extrusion at a fixed rate by the inverted method were determined for different temperatures, and the existence of a simple relationship between pressure and temperature of extrusion was confirmed. Evidence is given to show that the comparison obtained can reasonably be extended to cover rates of extrusion used industrially. The system of flow in billets was determined by observing the distortion of checker-board markings on a split billet. The influence of extrusion temperature on mechanical properties of the alloys was determined. JLG (D-4b)

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O. E. HARDER, SECTION EDITOR

Low-tungsten Substitutes for High Speed Steel. A. GORBUNOV & YA. DOVGALEVSKII. *Stal*, Vol. 8, May 1938, pp. 55-60. In Russian. Original research. EI173 (1.10% C, 9.20% Cr, 2.38% W, 0.81% V, 0.25% Si) and EI184 steel (0.98% C, 8.68% Cr, 4.08% W, 1.56% V, 0.62% Si) retain 65% austenite after oil quenching from 1200° C. A single draw at 550° C. decreases the austenite in EI173 to 37% and in EI184 to 29%. A triple draw at 550° C. reduces the residual austenite in each to about 20% with a Rockwell C hardness of 64. Almost complete transformation of the austenite was attained by quenching from 1180-1200° C. in a Pb bath at 600° C. and drawing 3 times at 550° C. for 1 hr. each. Cutting tests showed that these steels stood up better than an 18% W, 4% Cr and 1% V steel. HWR (5)

An Internally Heated Liquid Salt Bath. *Machinery, London*, Vol. 53, Oct. 6, 1938, pp. 14-15. Practical. External heating is inefficient, and leads to excessive pot wear, high stresses in the pot, and non-uniform work, as well as difficulty in control. Internal heating with a.c. current and 2 electrodes overcomes all these disadvantages. There is a minimum of heating energy lost to the external atmosphere, the pot is not subjected to local (external) heat concentration, constant bath circulation is automatic and provides uniform heating, and control is unusually easy. JZB (5)

Atmosphere Controlled Batch Type Furnaces. *Wild-Barfield Heat-Treatment J.*, Vol. 3, Sept. 1938, pp. 23-25. Descriptive. Although atmosphere for a batch type furnace may have been very carefully selected, prepared and controlled, such furnaces are seldom gas-tight and much of the attention to atmosphere may be vitiated by air leakage into the chamber. Furnaces are described that incorporate gas-curtains and door seals claimed to prevent ingress of air and therefore to avoid variations in furnace conditions with each opening of the door. The entire furnace is unusually clean and very compact. FPP (5)

Induction Heating. A. J. G. SMITH. *Electrical Rev.*, Vol. 122, June 24, 1938, p. 910. Induction heating is being used successfully for heating of tube, shell and billet ends prior to forging, and end sections of large steel tubes for subsequent swaging operations. Special focus 1-turn coil heats tube end to 1200° C. in about 1 min. With a straight coil, section of a 3 in. diameter billet can be heated uniformly to 1200° C. in 2 min., or 7 in. sq. billet to same temperature in 15 min. About 400 kw.-hrs. are required to heat a ton of steel to forging temperature. Graded temperature can be provided. MS (5)

5a. Ferrous

O. E. HARDER, SECTION EDITOR

The Necessity for Control of Steels and Their Heat Treatment. R. J. BROWN. *Wild-Barfield Heat-Treatment J.*, Vol. 3, Dec. 1938, pp. 27-30. Interesting discussion of production problems. The main causes of variation in quality of heat-treated automotive products are reviewed, with illustrations of specific instances. Defective heat treatment due to errors in pyrometer control can usually be blamed on failure to check instrument standardization; wherever possible 2 thermocouples should be installed in each furnace, one at the rear for recording and one at the front for control. For the treatment of transmission gears and similar parts, special furnaces, incorporating preheat, soaking and equalizing zones, are recommended. The use of alloy steel is advocated for massive parts where there is strong likelihood that C steel cannot be sufficiently-deeply and uniformly hardened even in water quenching. Several types of defective structures are illustrated, with particular emphasis on the bad effects of primary ferrite network resulting from insufficient temperature or time of heating at hardening temperature. In carburizing, most distortion can be traced to variations in the steel itself, *i. e.* to uneven working of parts of the stock during forging, or to uneven or too coarse grain size. FPP (5a)

The Effect of the Silicon and Aluminum Addition on the Hardenability of Commercial Steels. M. J. R. MORRIS & H. W. MCQUAID (Republic Steel Corp.) *Am. Soc. Metals*, Preprint No. 27, 1938, 27 pp. Original research. The relative effects of small Al and Si additions on the hardenability of a C steel were studied. Six 100-lb. ingots were cast from two 300-lb. heats melted in an arc furnace under an open hearth finishing slag. Al and Si additions were regulated to give the following analysis:

Heat	A	B	C	X	Y	Z
C	0.43	0.45	0.44	0.42	0.42	0.40
Mn	0.95	0.99	0.97	0.95	0.95	0.98
Si	0.005	0.07	0.24	0.01	0.10	0.25
Al	0	0	0	0.046	0.052	0.052
Al_2O_3	0.006	0.003	0.003	0.009	0.009	0.008

The ingots were rolled to 1¼ in. diameter bars. Ingots X, Y and Z showed an A.S.T.M. No. 5-6 grain size in the as-rolled condition. A, B and C were somewhat coarser (A.S.T.M. No. 3-5) as-rolled. The low Al heats showed less free ferrite as-rolled. When normalized at 2000° F., all heats were coarse (A.S.T.M. No. 1-3), there being no indication of a variation in Al or Si content. The carburized (McQuaid-Ehn) structure showed the effects of the high Al additions. X, Y, Z were fine grained (A.S.T.M. No. 6-7) while A, B and C were coarse (A.S.T.M. No. 2-3). Grain size was independent of Si content. After the normalizing treatment, specimens were heated to 1500°, 1700° and 1800° F., held 15 min., and quenched in water. After the 1500° F. quench, the 2 high-Si heats, C and Z, were definitely harder than A and X. The fine-grained steel Z hardened as well as the definitely coarse-grained steel C. At 1700° F. heat C was slightly harder than Z. The fine-grained Al-treated Z hardened better than coarse-grained heat A, which in turn showed a better hardenability than the low-Si fine-grained heat X. At 1700° F. Si content was more important than grain size or Al content. At 1800° F. the high Si heats again indicated greater hardenability than the low Si heats. Apparently, difference in hardenability was related more to difference in Si than to grain size or Al. When reheated to 1500° F. from the as-rolled condition, the results differed but slightly from the normalized material. After holding at 1275° F. for 24 hrs. and quenching from 1500° F., there was little difference in the hardenability of the steels tested, the hardenability of all the steels decreasing greatly. Quenching of the steels from 1500° F. in 8% caustic failed to show any marked difference in hardenability between the coarse and fine-grained steels. These experiments indicate that the real causes of variation in properties of this type of steel after quenching are not known. The relation between the physical size of the austenite grain at the time of quenching and hardenability is thought to be less important than low-C austenitic areas, which are present due to non-uniform C solution and diffusion. Al, which expands the ferrite lattice, and Si which contracts it, respectively promote and retard carbide diffusion and thereby affect carbide distribution and hardenability. HLW (5a)

Rolling Mill Instrumentation. J. L. WHITTEN (Lee Wilson Eng. Co.) *Instruments*, Vol. 11, Dec. 1938, pp. 301-302. Original research. The control of rolling temperatures is the latest development in the field of mill instrumentation. The use of photocells and electron tubes to speed the operation of radiation pyrometer equipment pointed the way to the development of equipment that now can record every variation in temperature along the entire length of the bar, billet or slab. The instrumentation in continuous strip, merchant, blooming, pipe welding, rail, wire rod and seamless tube mills is considered. The author's pioneering work in the dual control application to radiant tube fired furnaces is described. The basic principle is to control the tubes to limit them until the steel has reached its control point, and at that time to switch over automatically from the tube thermocouple to the steel thermocouple and maintain the desired steel temperature, while the tubes continue to fall in temperature during the soaking part of the cycle. Atmosphere control in furnaces of the batch type is desirable. It is predicted, for direct-fired furnaces, that equipment will be available soon that will automatically regulate furnace atmospheres on a definite program to provide different types of atmosphere at different times during the heating cycles. EF (5a)

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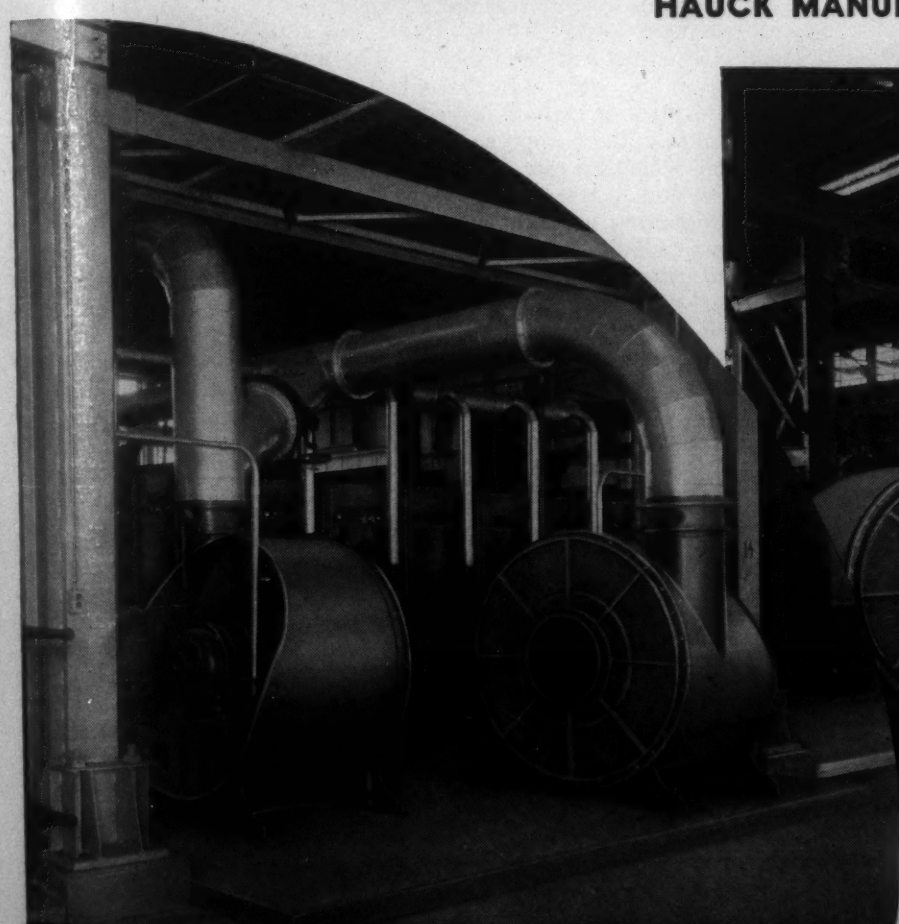

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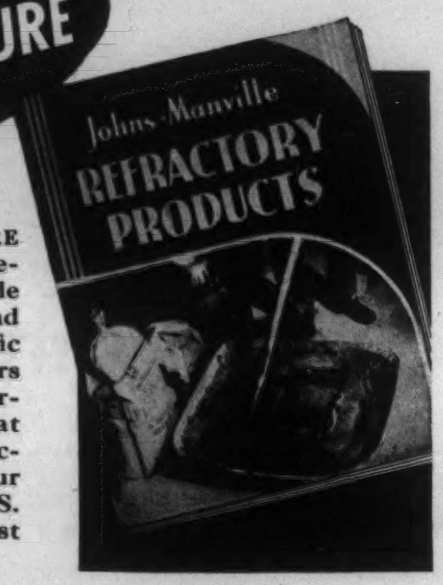

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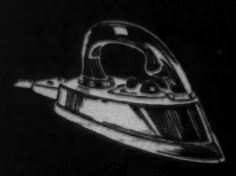

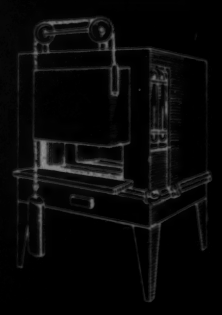

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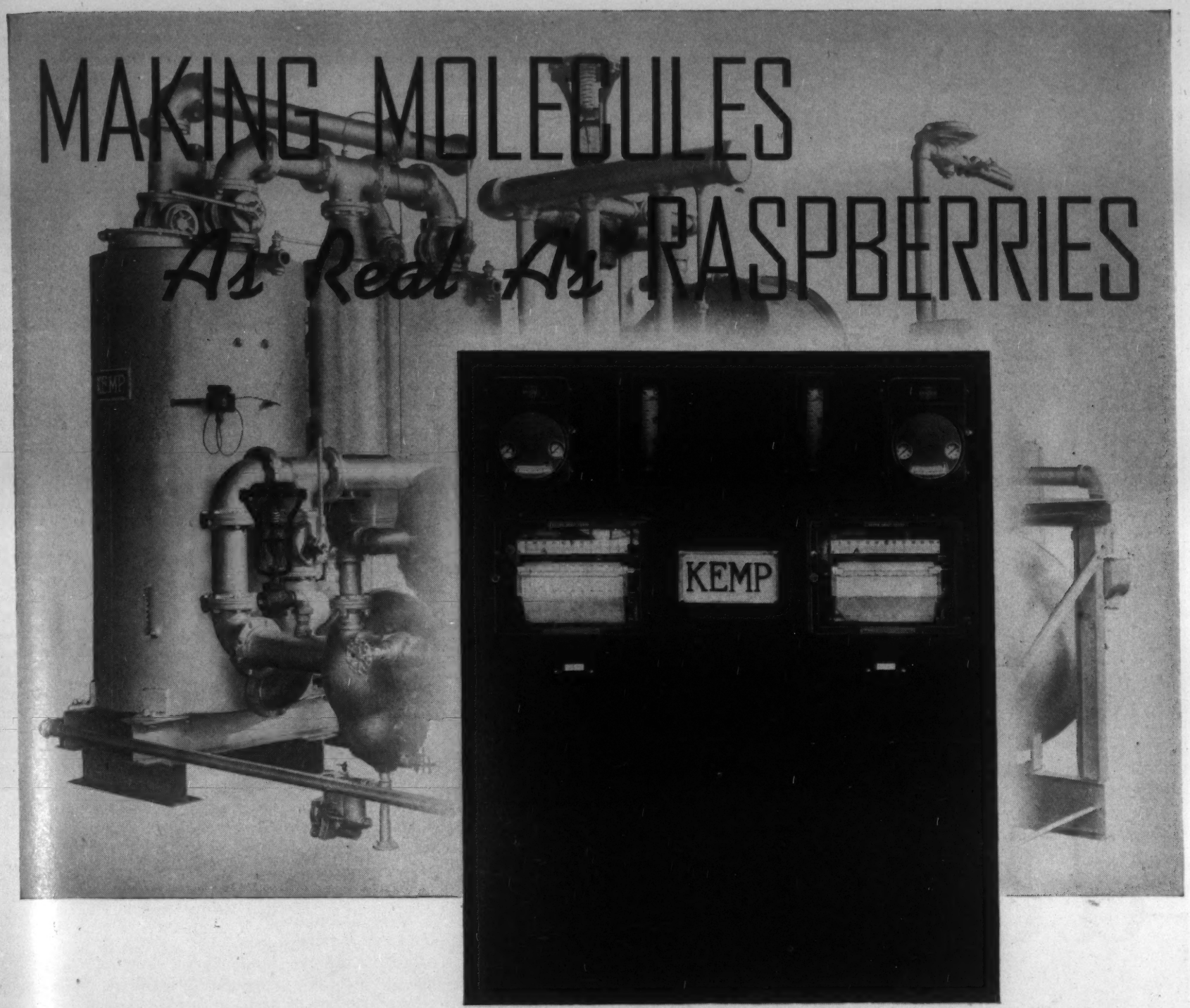
Enlarges Axle Plant. E. F. KENNEY (Bethlehem Steel Co.) *Steel,* Vol. 103, Dec. 5, 1938, pp. 50-52. Describes forging, heat treating, and finishing of axles at Johnstown, Pa., plant of Bethlehem Steel Co. Practices and controls result in precision forgings approaching rough-turned parts in accuracy. All axle blooms are control-cooled to insure slow, uniform cooling. They are heated in a pusher-type furnace with 580 sq. ft. of hearth area. Burners are arranged across front of furnace and flames pass over steel to flue in back. Heated blooms are rolled to desired diameter and immediately forged. Forging is placed on a cooling bed, and when still at a dull red heat, is straightened in a special press. Heat treatment or slow cooling then follows. Driving axles and special items are forged directly from heated bloom without rolling. Special furnace with 252 sq. ft. hearth area is used for these products. Practically all alloy steel and many special forgings are heat treated. Alloy steels and high-C steels are always charged on a cold hearth. There are 2 heat-treating furnaces, each with 443 sq. ft. hearth area and rows of burners along each side, arranged so flame does not directly contact steel. Treatment of charge considers both grain size and physical properties desired. In annealing, forgings are heated to desired temperature, soaked, cooled in furnace to well below critical point, and placed on cooling bed. In normalizing, forgings are heated to desired temperature, soaked, pulled from furnace and cooled in air almost to room temperature, heated slowly to drawing temperature, soaked, cooled in furnace and placed on cooling bed. Quenching procedure is same as used in normalizing, except that forgings are quenched in H_2O or oil when first removed from furnace and are immediately recharged to drawing furnace. Forgings are soaked at rate of 1 hr. per 1 in. diameter. Proper flame is used to prevent excessive scaling. All furnaces are heated with coke-oven gas and have pyrometer control. MS (5a)

The Softening Rate of a Steel when Tempered from Different Initial Structures. E. H. ENGEL (Carnegie-Illinois Steel Corp.) *Am. Soc. Metals,* Preprint No. I, 1938, 16 pp. Original research. Specimens of a steel (0.94% C, 0.40% Mn) were heat treated to 4 structures: Martensite, bainite (dark etching acicular product of austenite transformation at constant temperature), fine nodular pearlite and coarse pearlite. The treated specimens were tempered for a period ranging from 2 sec. to 22 hrs. at temperatures of 600°, 900°, 1050,° 1200° and 1300° F., and the hardness and microstructures determined. The rate of softening during tempering of the steel was dependent on the initial structure. The finer the state of carbide dispersion before tempering, the faster was the decrease in Brinell hardness during tempering. In the order of their softening rate, the structures were martensite, bainite, fine pearlite and coarse pearlite—the last being the slowest. At the high tempering temperatures the 4 structures approached a common hardness which decreased more and more slowly with increased time at temperature. The study indicates that under appropriate tempering conditions the martensitic surface region of a section of quenched steel that failed to harden all the way through may be made softer than the relatively soft (pearlitic) core that did not harden on quenching. The U-shaped curve representing hardness distribution in a quenched cylinder can be flattened out and even inverted by a selection of time-temperature conditions of tempering. When a well-spheroidized uniform structure is desired on tempering, an initial structure of coarse pearlite should be avoided. HLW (5a)

The Heat-brittleness of Steel. IWAO HAGIWARA. *Tetsu-to-Hagane,* Vol. 24, Jan. 25, 1938, pp. 13-24. In Japanese. The relation between the heat-brittleness and the heat-treatment of steel are studied. Specimens of basic open hearth steel containing 0.2 and 0.3% C and Ni-Cr steel containing 3.4% Ni, 0.7% Cr and 0.28% C, which were cooled from 900° and 850° in various mediums, such as water, oil, air, etc., were subjected to tensile testing at various temperatures between 20° and 800° C. to determine the strength and the reduction of area. The precipitation of cementite dissolved in α-Fe below A_1 causes a brittleness different from the familiar temper-brittleness that occurs at lower temperature. The former brittleness appears only when cementite separates in pearlite form but not in sorbitic. The temper-brittleness range is independent of the cooling rates of specimens so long as martensite is not formed. The so-called "secondary brittleness" (at 500°-700° C.) appears in coarse-grained specimens. The same type of study was made of Ni-Cr steels containing various amounts of C, Ni, Cr, Mo, Mn and Si. All these elements, particularly C and Mn, promote secondary brittleness. (2) Cr and Mn shift this type of brittleness to lower temperatures. (3) As the content of Mn and Si increases, a new brittleness appears below the critical point. TS (5a)

Scale Free Hardening of Screw Products. *Iron Age,* Vol. 142, Aug. 25, 1938, pp. 34-35. Practical description of a heat treating furnace. Parts varying from ¼ in. in diameter by ¾ in. long to ⅞ in. in diameter to 12 in. long are uniformly hardened in this furnace without scaling. Pickling or rolling of threads after hardening is eliminated. Maximum production is obtained by placing products of predetermined weight in the furnace at exact intervals. VSP (5a)



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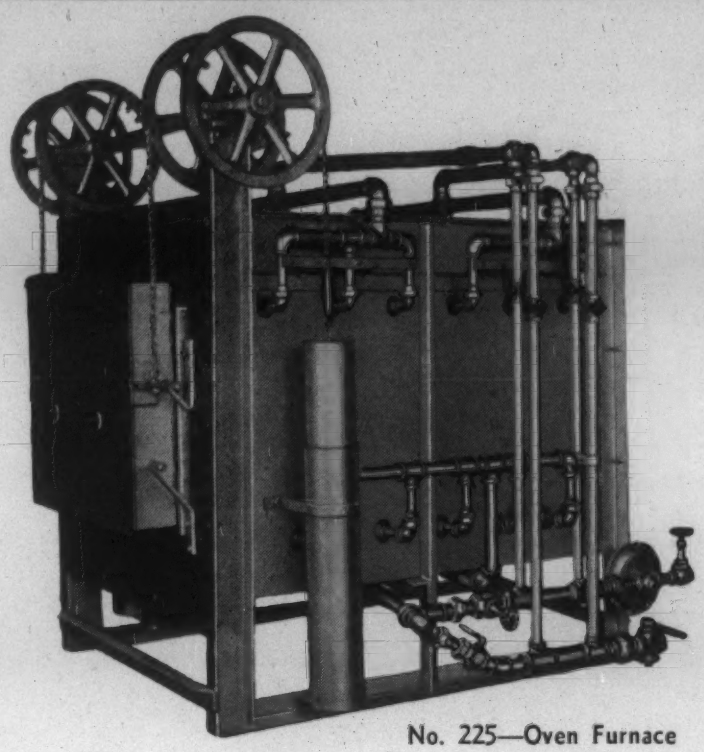

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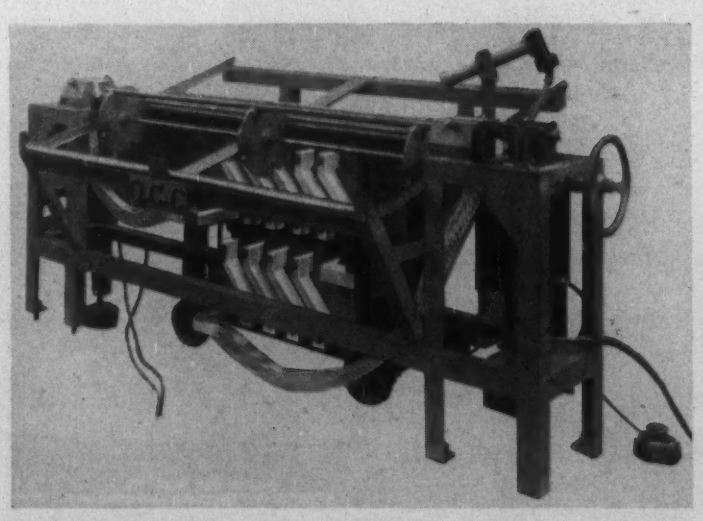

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Autogenous Hardening of Cast Iron and Malleable Castings (Autogenes Härten von Gusseisen und Temperguss) G. KRITZLER & F. ROLL. *Giesserei,* Vol. 25, Dec. 2, 1938, pp. 609-617. Experiments have shown that blackheart malleable castings can be made by autogenous surface hardening (flame hardening), more suitable for certain purposes. The surface can be made pearlitic, sorbitic, martensitic and cementitic to martensitic according to the heat-treatment applied; the hardness can be varied between 200 and 600 Brinell. The higher the temper resistance of the material must be, the more the hardening must tend to produce a cementite structure. Quenching in air, oil and water is applied according to the desired hardness. The flame must have an acetylene excess to avoid decarburization at the marginal zones; the most favorable structural condition is obtained if the surface has not been decarburized by the annealing process. A martensitic structure loses its hardness at 100° C., while a cementitic structure is stable up to 280° C. Crankshafts so hardened have shown no measurable wear after 56,000 miles. The fatigue strength is very good, as correctly hardened surfaces maintain a tough core of ferrite and temper C. Fatigue fracture occurs in such hardened parts much less than in hardened steel alloys, as stress peaks are absorbed in the temper C. Ha (5a)

The Effect of Type of Cold Deformation on the Recrystallization Properties of Armco Iron. HERMAN F. KAISER & HOWARD F. TAYLOR (Naval Res. Lab.) *Am. Soc. Metals,* Preprint No. 17, 1938, 38 pp. Research. The relation between the amounts and kinds of cold deformation required to produce recrystallization in Armco Fe when annealed at various temperatures was determined for 2 lots of Fe. Deformations studied were: Torsion, elongation in tension and rolling. Prior to cold working, all specimens were given a uniform initial grain size by heating back and forth through A_3 (875°-923° C.). Critical values were arbitrarily chosen as mean values of 2 deformations, between which there occurred a marked change in grain size. After deformation, specimens were annealed for about 3 hrs. at temperatures ranging from 300° to 875° C. In the case of samples manifesting coarse grains after deformation and annealing, many small grains were located in the boundaries of the larger grains. Results are summarized in recrystallization diagrams. It is possible to relate the critical degree of deformation for an annealing temperature for the 3 types of cold deformation by expressing the degree of deformation in terms of octahedral shear. Studies on the effect of annealing time established that the critical degree of reduction decreased as the length of annealing time increased. HLW (5a)

Furnace Stress-relieves Vessels that Are Longer than Itself. *Steel,* Vol. 103, Nov. 14, 1938, p. 67. Descriptive. Furnace at Birmingham, Ala., plant of Chicago Bridge & Iron Co., is 80 ft. long inside, 14 ft. wide and 17½ ft. high to crown of arch. It has a standard gage track. Furnace bottom consists of a specially-constructed 28-wheel car 83 ft. long, floored with 4½ in. of insulating concrete and 13½ in. of insulating fire-brick. Meehanite supports carry vessel. Sides of arch of furnace have 9 in. of insulating fire-brick. Doors at both ends are lined with 10 in. of insulating concrete. Vessels longer than furnace are handled in 2 operations, with an end extending out of furnace each time. A temporary brick inclosure is built around vessel where it leaves end of furnace, sealing it. By-product coke-oven gas is burned in 64 low-pressure type burners, divided equally between top and bottom of furnace. Burners are divided into 12 zones with balanced valve regulator and dial-type recording pyrometer that actuates a 4-position controller on air-supply pipe for each. MS (5a)

Rapid Malleableizing (Ueber Schnelltemperguss) E. PIWOWARSKY. *Giesserei,* Vol. 25, Nov. 18, 1938, pp. 584-594. Review. American and European malleableizing practice is surveyed, and effect of temperature and chemical composition on velocity of malleableizing and on properties of malleable castings are illustrated by many diagrams and micrographs. Increasing annealing temperature results in increased carbide disintegration, which is accelerated by previous quenching. The formation of ferrite has a relation to the carbide disintegration; a periodic process exists, involving carbide disintegration with subsequent solution of C. A malleable casting containing more or less ferrite can be obtained by correct timing of the interruption of the annealing process. Recently, experiments were made in malleableizing with high frequency current, which resulted in a somewhat finer grain and temper C; the Fe used had the composition C 3.20%, Mn 0.35%, Si 0.55%, P 0.08%, S 0.020%. 19 references. Ha (5a)

Steel Mill Pouring Pit Refractories. *Ind. Heating,* Vol. 5, Dec. 1938, pp. 1157-1162. Review of a symposium. The following subjects are treated: *Refractories for Bottom Cast Pouring,* W. C. KITTO. *A Study of Factors Influencing Pouring Rates of Nozzles,* E. C. HITE. *Pouring Pit Refractories,* D. L. MCBRIDE. *A Memoir about Steel Pouring Refractories,* C. L. KINNEY. *Pouring Pit Refractory Practice in Great Britain,* W. J. REES. Materials used, properties they must have, design, composition, practices in different countries and methods of laying and joining bricks are described. Ha (5a)

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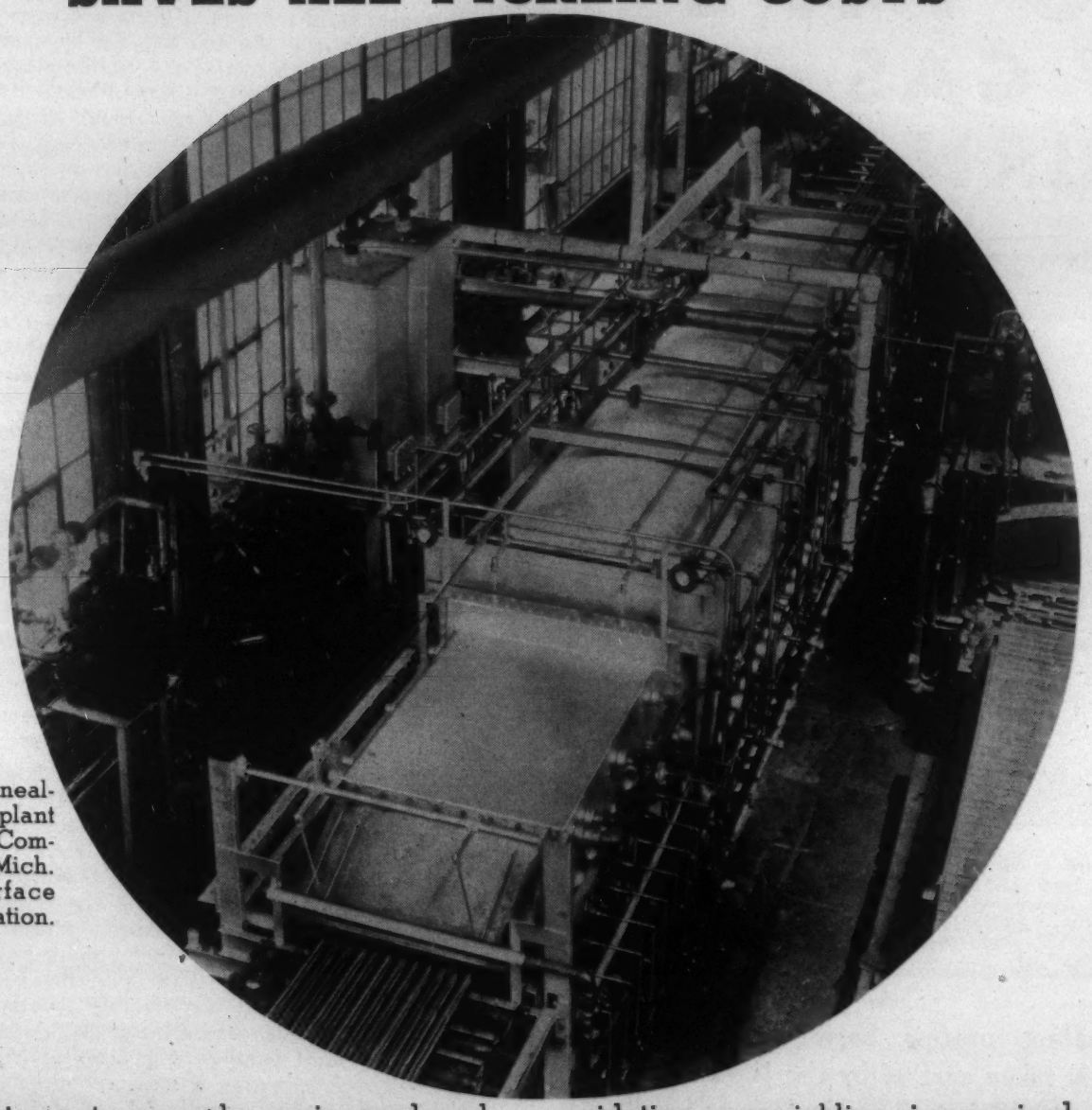

Open-fired, bright annealing GAS furnace in plant of the Mueller Brass Company, Port Huron, Mich. Photo courtesy Surface Combustion Corporation.

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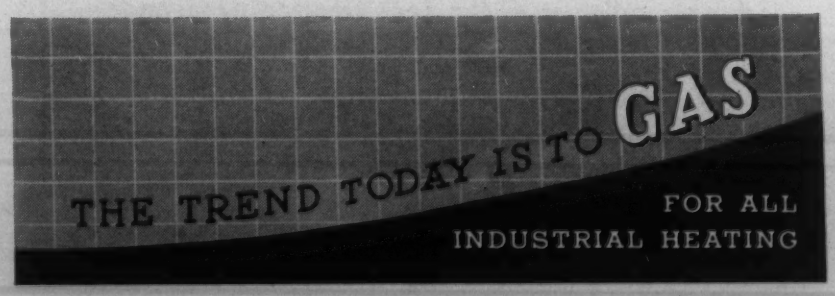

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5b. Non-Ferrous

M. E. MAWHINNEY, SECTION EDITOR

Investigation of Normal and Accelerated Aging by Thermoelectric Studies (Beitrag zur Frage der Kalt- und Warmaushärtung auf Grund thermoelektrischer Untersuchungen) A. DURER & W. KÖSTER. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 311-319. Experimental. "Normal" or "low temperature aging" is described as the agglomeration of atoms of the second phase in a supersaturated solid solution without the formation of a new crystal lattice. "Accelerated" or "high temperature aging" is considered as true precipitation of a new lattice type from a supersaturated solid solution. These processes were followed in an alloy of Al with 4% Mg and 8% Zn by measurement of the electrical resistance and thermal e.m.f. of the alloy. By annealing for various lengths of time at different temperatures, 4 classifications can be made: (1) Increasing normal aging, (2) decreasing normal aging, (3) increasing accelerated aging, (4) coagulation of the precipitated phase. These can be distinguished by breaks in the curves of the thermal e.m.f. against temperature. The maximum possible normal aging was determined for each temperature and a limiting temperature established, dependent upon the time at temperature below which only normal aging could be realized. Heating for short periods of time destroys the effects of normal aging, but such treatment does not eliminate subsequent accelerated aging. This treatment does change the rate of accelerated aging, however, and the 2 processes cannot be regarded as independent of each other. GD (5b)

Age-hardening of High Coercive Force Iron-nickel-aluminum Alloy. A. A. KUZNETSOV. *Metallurg,* Vol. 13, July/Aug. 1938, pp. 59-64. In Russian. Original research. Structural aging of an alloy containing 27% Ni and 15% Al was studied at 20°, 100°, 300°, 400° and 500° C. The coercive force rises and reaches a maximum after 20-25 days at 20°, 35-45 hrs. at 100°, 11-15 hrs. at 300°, 2-3 hrs. at 400° and 1 hr. at 500° C. After reaching the maximum, the coercive force drops somewhat and becomes nearly constant. The drop is nearly the same (6-7%) in all cases and is independent of the temperature. The temperature affects only the time of stabilization. Thus, at 20° C. structural stabilization is reached after 100-120 days, at 100° C. after 65-70 hrs., and at 300°-500° C. after 18-24 hrs. BZK (5b)

The Aging of Aluminum-magnesium-zinc Alloys and Recovery from Low Temperature Aging (Ueber die Aushärtung von Aluminium-Magnesium-Zink-Legierungen und die Rückbildung der Kaltaushärtung) W. KÖSTER & K. KAM. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 320-322. Experimental. Aging curves, showing the effect of heat treatment on the Brinell hardness, and tensile properties of a number of Al-rich alloys in the Al-Mg-Zn system were determined. The values obtained depended more upon the type of heat treatment than upon the phases participating in the aging reaction. The considerable low-temperature aging effected by holding the quenched alloy at 20° C. for 9 days could be almost completely eliminated by annealing at higher temperatures, about 200° C., for less than a minute. GD (5b)

Heat Treatment of Non-ferrous Metals and Alloys. RALPH D. HAWKINS (Bridgeport Gas Light Co.) *Heat Treating Forging,* Vol. 24, Nov. 1938, pp. 569-574, 577. Report of Non-Ferrous Metals Committee, Industrial Gas Section, Amer. Gas Assoc. Summary of the operations through which an ingot of Cu or its alloys may pass before reaching the finished stage. Describes major operations in sheet, tube, wire and rod mills and in fabricating plants, with chief attention to their requirements relative to fuel and furnace equipment as far as generally accepted practice is concerned. Points out general trends. MS (5b)

The Investigation of Aging Phenomena. Part I. The Influence of Al, Fe, Co and Cr on the Aging of Corson Alloy. K. IWASE, M. OKAMOTO, A. ADATI & I. SUZUKI. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Sept. 1938, pp. 419-430. In Japanese. Original research. In order to eliminate the maximum in the hardness-time curve of Corson alloy aged at 500° C., additions were made of Al, Fe, Co and Cr, the amount for Al being 1-10% and for others less than 5% each. Although the object can be attained by adding Al alone, further improvement was made by additions of Fe and Co, besides Al. Cr was not as effective as Fe and Co. NS (5b)

A Dialogue on the Embrittlement of Cu. T. S. FULLER. *Gen. Elec. Rev.,* Vol. 41, July 1938, pp. 312-313. Review, in socratic dialogue, of the problem of O in Cu, a factor still causing difficulties for the engineer. Tough pitch Cu with 0.03-0.04% O can be embrittled when subjected to reducing atmospheres, such as H_2 and CO. Not only is the O present as Cu_2O reduced, but the O dissolved in the Cu is also affected. The only remedy is the substitution of "O-free Cu" if the material is to be heated in a reducing atmosphere. FHC (5b)

6·WELDING AND CUTTING

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

E. V. DAVID, SECTION EDITOR

Silver Alloy Brazing of Tubes in High Pressure Boilers. A. W. WEIR & H. M. WEBBER. *Welding J., N. Y.*, Vol. 17, Oct. 1938, pp. 50-56. Practical. The problem of brazing of Cu tubes into steel tube sheets presented itself as a result of frequent failure of mechanical joints with consequent leakage. Fire tube boilers used for heating passenger cars and for hot water were formerly expanded into tube sheet by means of steel ferrule, but differential expansion of Cu tubes and steel sheet along with vibration opened up the joints. Welding of the tubes to the sheet by several methods has been investigated, but so far has not produced satisfactory results. The Ag alloy brazing process, however, using the furnace brazing method and joining all tubes at one time appeared to be feasible. Consideration had to be given to furnace atmosphere because of the use of P-deoxidized Cu, which could not be considered as completely and consistently deoxidized. Tests were made of 3 furnace atmosphere mixtures as follows:

	No. 1	No. 2	No. 3
CO_2	10.6	0	10.6
O_2	0	0.2–0.4	0.2
CO	0.2	0	0
H_2	0.3	0	0
N_2	88.9	99.8–99.6	89.2

Use of No. 1 gas resulted in embrittlement on outer surface of Cu tube and complete embrittlement on tough pitch Cu, while No. 2 and 3 showed no embrittling effect, owing to slightly oxidizing character of atmosphere. Due to the latter the flux had to be depended upon to prevent an oxidized surface into which the Ag alloy was to flow during furnace treatment. Production test was made on assembled tube bundle made up with mechanically and chemically cleaned Cu tubes set into tube sheet and placed on pedestal of a bell type furnace. The tubes were in vertical position during furnace cycle of 4½ hrs., 2 hrs. to heat to 1240° F. The tube sheets were prepared by applying flux to all tube holes and inserting a ring of Ag brazing alloy; Cu tubes were then inserted and flux applied on ends. Examination of the joints indicated that jointing was perfect, and severe steaming tests made on the completed boiler showed that exceptional strength and resistance to rapid temperature changes had been attained. The reduction of maintenance costs will justify the furnace brazing method of producing the boiler. Illustrations for various phases of production, and micrographs of the bond formed between the steel and Cu tube are given. WB (6)

The Influence of Residual Stress on the Strength of Welded Seams. J. P. DEN HARTOG & O. E. RODGERS (Harvard Univ.) *Welding J., N. Y.*, Vol. 17, Nov. 1938, Suppl. pp. 1-3. A method is described for producing an internal stress distribution in plates similar to that found in welded plates, without changing the metallurgical structure of the plates. By this method the effect of internal stress on strength properties can be evaluated without any disturbing effect from the metallurgical changes produced by the welding process. The plates were subjected to destructive tensile tests in a direction parallel as well as perpendicular to the direction of the internal stresses. The cracks observed in welded structures of ductile boiler plate subjected to slowly varying stress are due, not to internal stresses, but to metallurgical modifications of the material. Stress annealing is therefore not necessary for structures that are subjected to unvarying or slowly varying stresses. CEJ (6)

Brazing Alloys. P. MABB. *Machinery, London*, Vol. 53, Oct. 6, 1938, pp. 17-18. Practical. Strength and melting point of the brass brazing alloys are a function of composition; latter can vary between 880° and 1050° C. The addition of AgCu increases the ductility, hardness and strength; AgZn increases the hardness and corrosion resistance. The Ag is usually added to the brasses at the expense of the Cu, giving alloys with melting points from 305° to 1045° C. Sn tends to reduce the ductility. A new P-deoxidized Ag-Cu alloy has been introduced. The Ag solders are preferable from the standpoints of fluidity, penetration, corrosion resistance, electrical conductivity, malleability and high strength. Borax is the most widely used flux. JZB (6)

The Metallurgical Aspects of Resistance Welding Electrodes. R. H. HARRINGTON (Gen. Elec. Co.) *Welding J., N. Y.*, Vol. 17, Oct. 1938, Suppl. pp. 18-22. Survey of history, present alloys in use and future metallurgical development. The early use of pure Cu, work hardened as in cold drawn bar stock, was excellent for electrical conductivity but proved to be costly to maintain as electrode material, because of ease of deformation. The next step in evolution was the use of Cu with 1% Cd, which could be work hardened to a greater extent than Cu and possessed sufficient conductivity to be useful as electrodes. With increase in resistance welding applications, the latter were grouped into 4 classes wherein specific applications of the best electrode alloy could be made for each class: (1) Plain C steels, (2) stainless (or alloy) steels, (3) non-ferrous alloys such as brasses and bronzes and (4) Cu. Each classification is considered in detail, and their own specific requirements are discussed. The electrode material for these welds cover a wide range from special bronzes, pressed powder mixtures of Cu, Ag and W to the use of pure W. Some of the Cu alloy compositions are tabulated with mechanical, physical and electrical properties as well as some of the Cu-W, W-Ag, W powder mixtures for which hardness values and electrical conductivity values are shown. Desirable properties of electrode materials are enumerated as: (1) suitable electrical conductivity, (2) high proportional limit, (3) maintenance of physical properties at as high a service temperature as possible, and (4) the "X-property," probably contact surface resistance. The future field for electrode metallurgy is considered to be in the precipitation hardenable alloys. WB (6)

Electrode Alloys for Welding Small Contacts. E. E. HALLS. *Aluminium & Non-Ferrous Rev.*, Vol. 3, Sept. 1938, pp. 391-392. Practical. Electrical contact metals should be non-tarnishing, non-arcing, abrasion resistant and have high conductivity. Flat discs and conical points, which can be riveted or welded to the holder, are used. Welding has many advantages. Contacts can be produced and welded on automatic machines. Cu as welding material fulfills many requirements but tarnishes, oxidizes and deforms under pressure. W has advantages but is low in electrical and thermal conductivity. A combination of both is used as a sintered alloy, containing 40% W and 60% Cu. Cu is also used with additions of 1% Cd, or 1% Cd plus 1% Ag; the additions increase the hardness. Age-hardening alloys for welding contact points contain *e.g.*: 0.48-0.53% Zn, 0.27-0.31% Cr, 0.19-0.21% Be, balance Cu. These alloys are not much better than Cu with regard to tarnishing and arcing, but are superior as far as wear and deformation are concerned. The ideal material has not yet been developed. RPS (6)

Bi-metal Construction of High Temperature Steel Valves. E. R. SEABLOOM (Crane Co.) *Welding J., N. Y.*, Vol. 17, Nov. 1938, pp. 28-36. Descriptive. Valve manufacturers are constantly confronted with metallurgical problems which the ever-increasing operating pressures and temperatures impose upon materials that enter into valve construction. In the oil industry, cracking stills are now in use with pressures at 3,000 lbs./in.^{2} and temperatures of 1200° F. The general practice, at least by the author's company, is to employ deposited surfaces on disks and seats of all valves used on steam pressures above 750° F. A Co-Cr-W alloy is one of the most popular deposited surfacing materials, because it possesses excellent resistance to wear, seizure and abrasion at high temperatures. It also withstands certain types of corrosion well and is fairly resistant to erosion. Manually operated oxy-acetylene torch is the usual process used. Preheating and slow cooling is the usual practice. CEJ (6)

Resistance Welding in the Automotive Industry. J. A. WIEGER (P. R. Mallory & Co.) *Ind. & Welding*, Vol. 2, Dec. 1938, pp. 54-60. Review. Resistance welding has steadily and rapidly improved since it was first put into operation. Automatic operation is noticeably gaining as operator fatigue is greatly reduced, thereby maintaining production at a high level. The results are: Faster operation, lower current consumption, longer electrode life and better, smoother and more uniform welds. CEJ (6)

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Low-temperature Silver Brazing Alloys. H. A. FOLGNER (Handy & Harmon) *Iron Age,* Vol. 142, Oct. 13, 1938, pp. 161-162, 164-169, 290. Practical discussion of the use of low temperature Ag brazing alloys for various types of metal joining. One of the alloys used is known as Sil-Fos, composed of 15% Ag, 80% Cu and 5% P. It is used for joining non-ferrous metals, principally Cu, brass and bronze. It has a melting point of 1185° F. and is free-flowing at 1300° F. Another alloy, known as Easy-Flo, begins to melt at 1160° F. and is usually free-flowing at 1175° F. It has Ag content of about 50%, balance Cu, Zn and Cd, and may be used for joining most of the ferrous metals. New development of flux to be used with these brazing alloys is known as Handy Flux. It begins to fuse at 800° F., and at 1100° F. is a thin active fluid that insures thorough wetting of joint surface by Ag brazing alloy. The applications of these brazing alloys in various fields are considered, such as: In the manufacture of air conditioning and refrigerating parts, assembling unit heaters, electrical industry, etc. Very little Ag brazing alloy is required, regardless of the nature of the joint to be made. Ag brazing alloy has tremendous possibilities for wider industrial use. VSP (6)

Welding Eliminates the Hot Box. W. C. SWIFT (Compressed Ind. Gases, Inc.) *Ind. & Welding,* Vol. 3, Jan. 1939, pp. 40-42. Practical. Hot boxes can be caused by the crown brass in locomotive drive box becoming loose. Phosphor bronzes, high in Pb, can be firmly welded to wrought and cast steel with the C arc. By changing the drive box pattern to leave only about 3/8 in. to 1/2 in. space between the surface of the axle journal and the inside surface of the drive box, and then welding a high phosphor-leaded bronze to the inside of the drive box surface, a successful design has been produced. The Southern Pacific Road and The Great Northern have successfully used this or similar repairs and construction. CEJ (6)

Some Aspects of Modern Brazing Practice. H. J. MILLER. *Metal Treatment,* Vol. 5, Summer 1938, pp. 64-70. Up-to-date review. Brasses with 60 or 54% Zn are used for brazing Cu and alloys with melting points above 950° C.; those with 50% Zn and the Ag solders for lower melting point alloys. Brass with 63% Zn has been used for Cu, but temperature and time of heating need careful control to restrict thinning of the Cu by solution in the brass. The Cu-P and Cu-Ag-P alloys have good self-fluxing properties, and the latter is being used for resistance brazing with C electrodes. 15 references. JCC (6)

Code Requirements in the Shipbuilding Industry. *Ind. & Welding,* Vol. 3, Jan. 1939, pp. 24-26. The codes, briefed and tabulated, include material from Lloyd's Rules and Regulations for Ship Construction and Repair, the American Welding Society's Marine Code for Welding and Gas Cutting and the American Bureau of Shipping Requirements for Ship Construction and Repair. This résumé is concerned primarily with the codes as far as hull and general structural work is concerned. No great disagreement either in principle or in practice is revealed. CEJ (6)

The Determination of Internal Stresses from the Temperature History of a Butt-welded Plate. O. E. RODGERS & J. R. FETCHER (Harvard Univ.) *Welding J., N. Y.,* Vol. 17, Nov. 1938, Suppl. pp. 4-7. The internal stress distribution to be expected in 2 plates, butt-welded together by the thermit process, is calculated from the experimental record of the variation with time of the temperature over the surface of the plate. This stress distribution is found to be in good agreement with the internal stresses measured by the relaxation method. CEJ (6)

6a. Ferrous

Welding High-pressure Piping, Essex Generating Station. H. WEISBERG (Pub. Serv. Elec. & Gas Co.) *Welding J., N. Y.,* Vol. 17, Nov. 1938, pp. 3-9. Practical. Paper describes the welding that was done in connection with the piping and, principally, the field welding of the high-pressure, high-temperature steam and water piping for the new unit of Pub. Serv. Elec. & Gas Co., N. J., the Essex Generating Station. This unit consists of a 50,000 kw. superposed turbine generator and two 600,000 lbs./hr. boilers operating with steam conditions of 1250 lbs., 950° F. at the turbine throttle. Preheating was found essential for the welding of C-Mo steel pipe. The cooling of the weld before completion and stress relieving often resulted in cracks. It was specified, therefore, that the pipe at the weld be preheated to a minimum of 400 F. and held at this temperature until the weld was stress relieved. The heat was generated in the pipe wall by electrical induction, the heating element being left in place during welding. The heating element was made up by wrapping the pipe on each side of the weld with several turns of heavy, bare Cu wire connected to a transformer delivering 20-40 volts at 60 cycles. Asbestos paper was used to insulate the wire from the pipe. Hand arc welding, using qualified welders under an insurance company inspection service, was used. The day may come when practically all power plant pressure joints will be made by welding. CEJ (6a)

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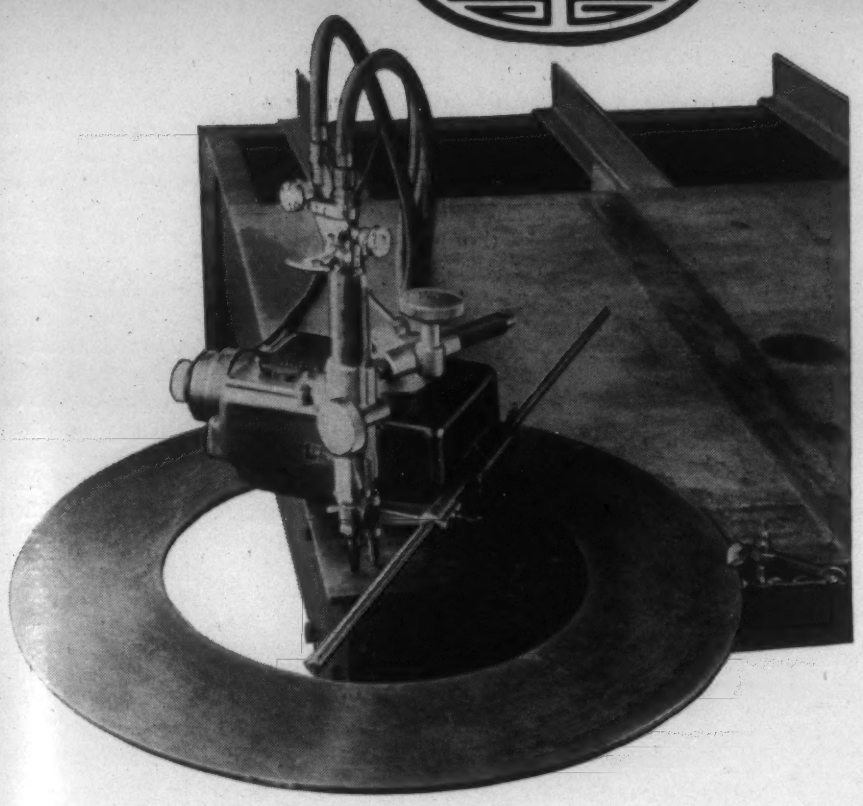

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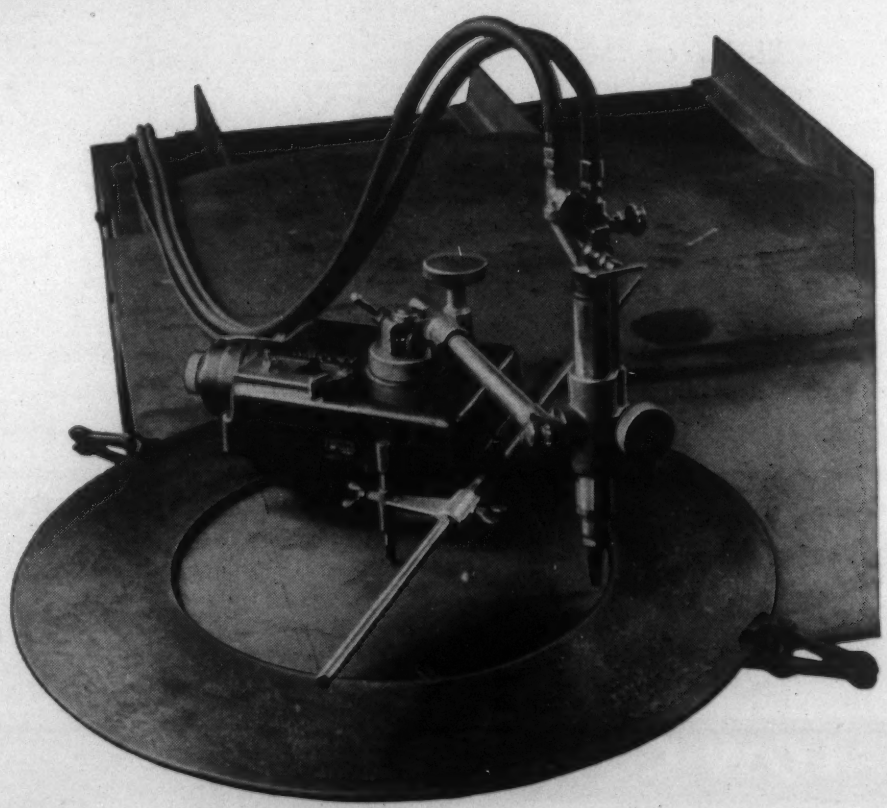

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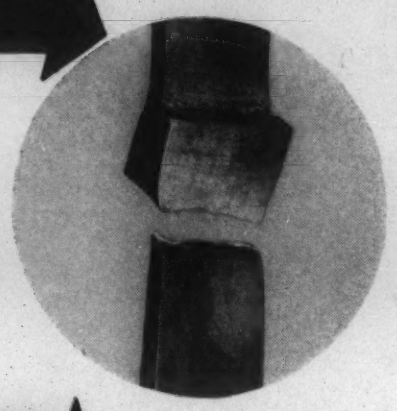

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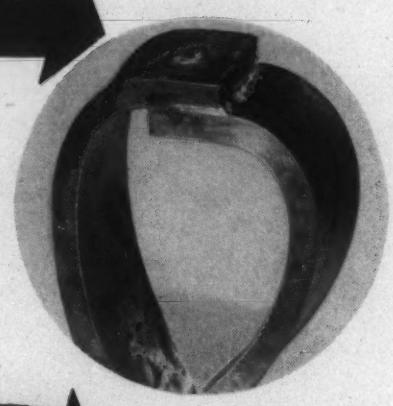

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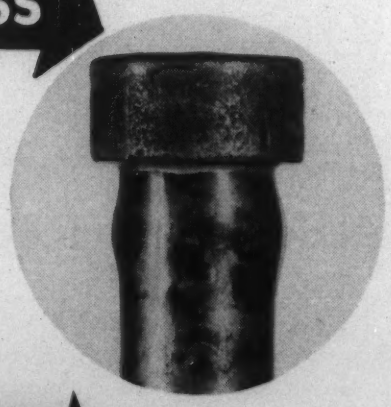

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Weldability of Medium Carbon Steel. R. W. Emerson (Westinghouse Elec. Mfg. Co.) *Welding J., N. Y.*, Vol. 17, Oct. 1938, Suppl. pp. 7-17. Original research, reported for steels of 0.30-0.50% C. Determinations of the thermal cycle for the heat-affected base metal under various conditions of welding were first made. The details of thermocouple size, temperature recording, etc., are not given, but a number of temperature-time curves for plates of varying thickness and for the 1st, 2nd and 3rd pass with and without preheat of multiple pass welds are shown. The curves present a clear picture of the effects of increasing plate size (mass) in inducing a rapid quench of the heat-affected area. The multiple pass thermal history indicates progressively lower rates of cooling as the number of passes increases, while the use of preheat brings about a remarkable uniformity in cooling rate for the 3 passes of the multiple pass weld. In order to define the hardenability of a series of steels ranging from 0.30 to 0.50% C with grain sizes of from 4-7 to 6-8, the author departs from the usual method of single bead welding on flat plates. Use is made of a 3-3½ in. round bar 10 in. long, and the welding beads are laid on the surface of the bar along the 10 in. length under various controlled conditions of welding in single bead for different electrode sizes and currents, in 2 and 3 pass welds, pre-heating, etc. The Vickers hardness values of the heat-affected zones are shown in curves, which bring out the beneficial effects of the multiple pass weld and preheat for the single pass weld. Macroscopic examination of the welds indicated that where preheat was used, the heat-affected zone had a wider extent and a gradual transition of macrostructure, whereas a steep temperature gradient established in welding initially-cold metal produced the most sharply defined heat-affected zone. A fine grain steel should show a narrower heat-affected zone and differences in other properties than a coarse grained steel, but results so far obtained are inconclusive owing to insufficient grain size contrast and extremely narrow range of heat-affected zone. The micros presented also reveal that striking differences in the heat-affected zone caused by differences in grain size are lacking. A detailed and helpful discussion accompanies the micros of heat-affected zone shown for various steels and welding conditions. Precautions include the choosing of electrode size suitable for thickness of plate to be welded, and the proper use of preheat and multiple pass welding in order to have austenite decomposition products other than martensite in the heat-affected zone.

Wb (6a)

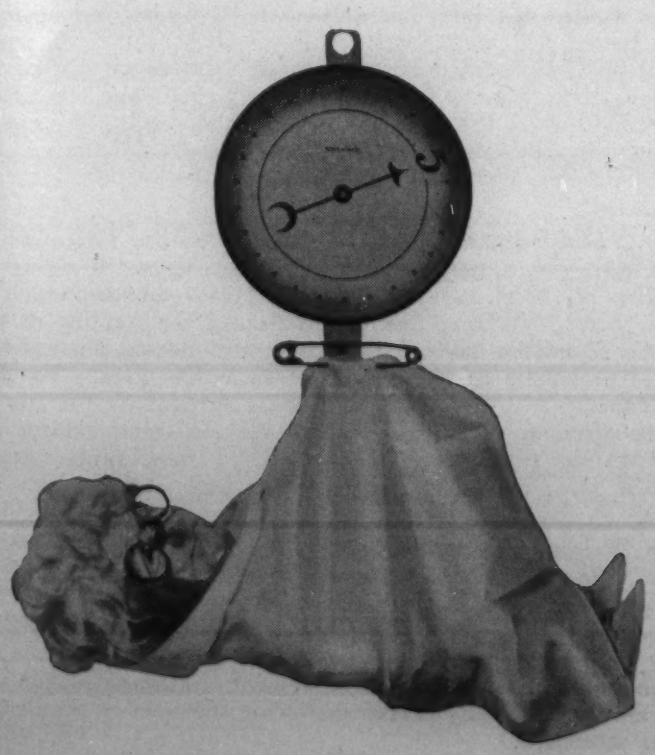
An Investigation of the Cored Electrode for the Arc Welding of Steel. I. The Effects of Elements in the Core on the Soundness of Deposited Metal. H. Sekiguchi. *Nippon Kinzoku Gakkai-Si*, Vol. 2, Sept. 1938, pp. 444-462. In Japanese. Original research. Steel core-rods containing one of the elements Co, Mo, Cu, Ni, W, V, Si, Ti, Al, C, Mn or Cr, were made, on which a flux consisting of 70% CaF_2 and 30% $Ca(OH)_2$ was coated. With these electrodes, single V butt joints of mild steel were made, and soundness of the welded joint was examined by X-ray and microscopic methods; the apparent specific gravity of the deposited metal was also measured. As the content of deoxidizer, such as V, Mn, Si, Ti, Al or C, increases in the core-rod of a coated electrode, the quantity of blow holes in the deposited metal decreases, but the non-metallic inclusion content increases except C. In the case of coated electrodes containing Cr or Mn many holes on the surface of beads appeared. **II. The Effect of Deoxidizers in the Electrode-core-rod on the Apparent Specific Gravity and Mechanical Properties of Deposited Metals.** *Ibid.*, Oct. 1938, pp. 483-494. With electrodes of many steel-core-rods containing 3 deoxidizers, Mn, Si and Al, in different proportions, on which was coated the same flux as described above, single V butt joints of mild steel were made. The use of electrodes containing a higher quantity of deoxidizers in the core-rod results in fewer blow holes and oxide inclusions in the deposited metals and much better mechanical properties.

NS (6a)

Arc Welding in the Automotive Industry. H. D. Doud (Gen. Elec. Co.) *Ind. & Welding*, Vol. 11, Oct. 1938, pp. 21-24, 70-72. Although but a small fraction of the metal used in an automobile is deposited by means of arc welding, those small weld-beads do the work that would require many pounds of metal if applied in any other way. Automatic arc welding is ideally suited to many repetitive welding operations involved in turning out the tremendous quantity of each component part. Rear axle housings are made from rolled plate formed into a tube, the seam being welded by use of atomic H arc welding process. The welded joint obtained in this way is so strong and ductile that it successfully withstands the piercing and repeated heating, expanding, swaging and forging operations that are necessary to achieve the final shape. Drive shafts, radius rods and torque tubes are made using the automatic arc welding equipment, with lightly coated electrodes. Large dies used in pressing out fenders are usually made with a body of a good grade of cast steel, while the cutting edges, forming edges or other portions subject to extreme pressures are built up of the desired quality of tool steel, using the atomic-H arc welding process.

CEJ (6a)

Whitey Sez:



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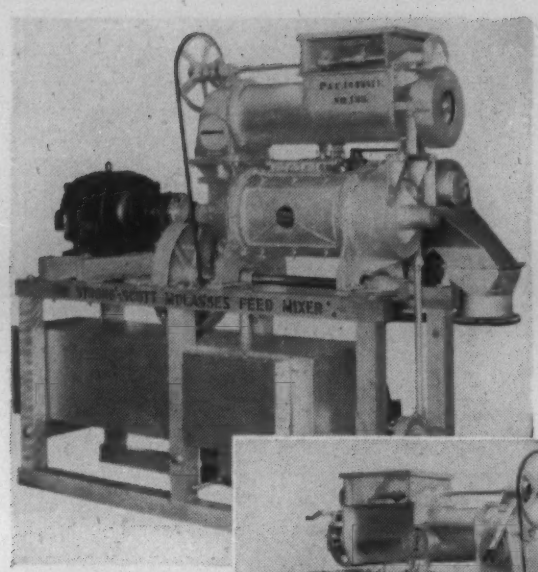

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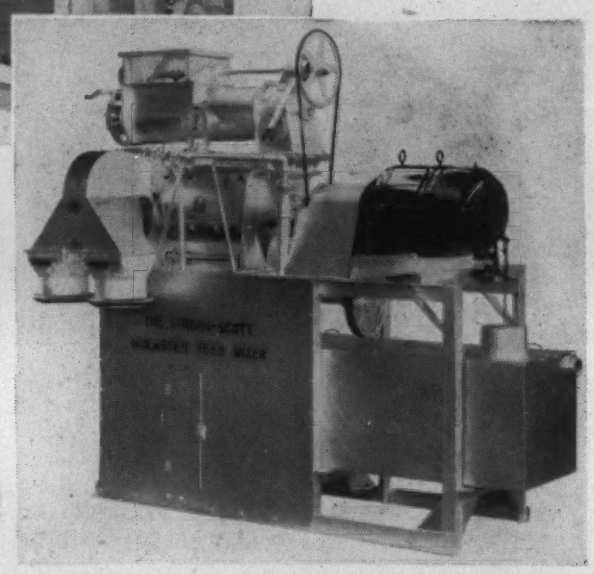

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Studies of the Spot Welding of Low-carbon and Stainless Steels. W. F. Hess & R. L. Ringer, Jr. (Rensselaer Polytech. Inst.) *Welding J., N. Y.,* Vol. 17, Oct. 1938, Suppl. pp. 39-48. Original research with a survey introduction of the lack of specific, quantitative information in the literature on spot welding. To remedy the latter defect, the authors map out the logic of a research program in which new facts are to be obtained under standard conditions to permit correlation of later research and data of other researchers. The problem was to determine the currents required to give best welds under varying conditions of pressure, time and electrode size. The methods selected for evaluation of welds were the shear test or tension on a lap weld, and microscopic examination. The latter gave information of highest value, since welds on either side of optimum current, pressure and time could be easily recognized. Methods of measuring current and calculating contact resistances are discussed, together with data presented in numerous curves for stainless steels. The results of microscopic examination of welds in stainless steels and mild steel are discussed from the many actual micros illustrated, and are correlated with the results of physical tests. Of the 9 conclusions reached, the following are the most important: (1) Maximum strength always occurs for maximum current that can be used without expulsion of metal during welding; (2) expulsion of metal during welding should be avoided to prevent cavitation, indentation and loss of strength; (3) 40-70% penetration of sheet thickness by fused metal is associated with the best physical properties; (4) microexamination of welds made in 2, 6 and 10 cycles indicates welds in stainless steels may be carried to 10 cycles without appreciable carbide precipitation and (5) microexamination of weld cross-sections can select varying qualities of spot welds. WB (6a)

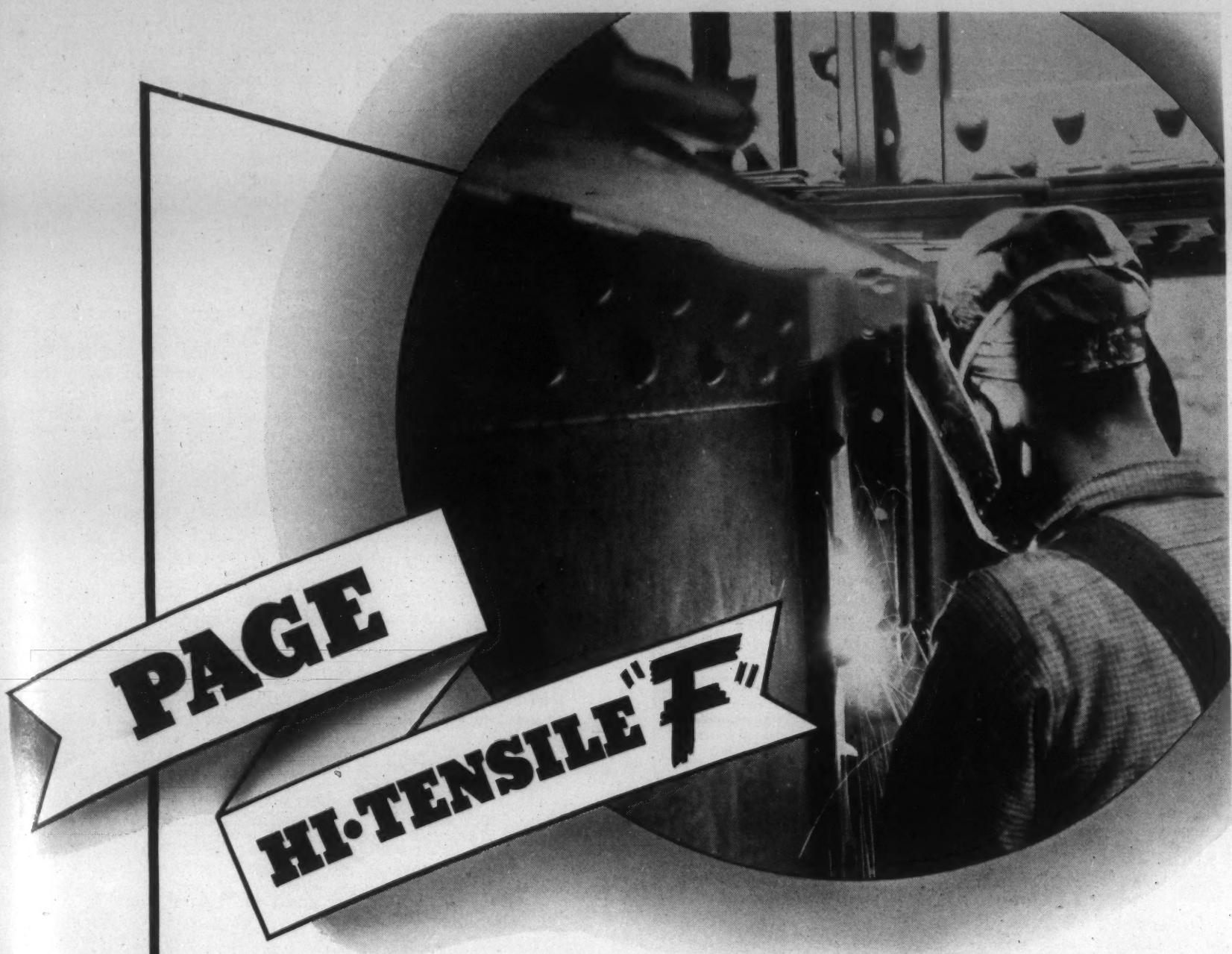
The Metallurgy of Welding. H. Harris. *Quarterly Trans. Inst. Welding, London,* Vol. 1, Oct. 1938, pp. 235-240. Original research data presented for cooling rate and welding tests, mostly on 5% Cr, 0.50% Mo steel. Theisinger's research on hardenability relations in welding is reviewed, with additional substantiating data collected by the author. The transformation rate of the 5% Cr, 0.5% Mo steel at various temperatures is considered in relation to the Bain S-curve. Delayed cracking and high hardenability are related to the long period of austenite stability at the lower temperatures from 875° C. to 1250° C. Data on the hardness obtained for equal cooling rates, and for varied cooling rates from 1000° C. and 1200° C. quench, are given and show that, even if cooled as low as 50° C. per hr., full hardness is retained when cooled from 1200° C. WB (6a)

Weldability of Nickel-alloy Steels Aids Fabrication. J. W. Sands (Internatl. Nickel Co.) *Welding Engr.,* Vol. 23, Nov. 1938, pp. 27-28. Practical. Advocates selection of a steel with less than 0.20% C in which the strength has been increased by alloying. Alloy steels containing Ni may show 50% or more increase in yield point. Coated electrodes are to be preferred and frequently unalloyed electrodes may be used in the welding of Ni and other alloy steels, since the deposit will be improved by absorption and diffusion of the alloy from the plate, or base metal. A steel with 0.25% C, 2.25% Ni and 0.65% Mn has been used successfully for fabrication of a pressure tank, welded construction, to be operated at a temperature of —75° F. Clad metals often require special welding procedures. CEJ (6a)

Modern Rail Welding (Neuzeitliche Schienenschweissung) H. Frankenbusch. *Tech. Blätter,* Sept. 18, 1938, pp. 547-550. Discussion of the present status of modern rail welding, referring particularly to the dynamic properties of rail joints. The autogeneously welded rail joint has an essentially higher fatigue limit than the bolted fish plate joint. Joints welded with rods newly developed by I. G. Farben possess fatigue limit twice that of the bolted fish plate joint. The welded joint maintains the same fatigue properties as the rail in service. The results of metallographic investigations of such joints are given. Joining of different rail profiles, welding of crane rails, rail crossings, etc., are also discussed. GN (6a)

Welding Molybdenum Steels, A Review of the Literature to July 1, 1937. W. Spraragen & G. E. Claussen. *Welding J., N. Y.,* Vol. 17, Nov. 1938, Suppl. pp. 12-21. Another excellent digest by these 2 authors, this time covering the welding of the Mo steels. Seventeen tables present compositions and physical and mechanical properties as gathered from various sources. The Mo steels contain up to 1% Mo, the Mo being particularly effective in raising the strength of low C steel at elevated temperature. In welding, Mo has little effect on hardness. Preheating and stress-relieving of some of the C and alloy-Mo steels is desirable. 47 references. CEJ (6a)

Repair Welding on Molds for the Cast Iron Pipe Industry. *Ind. & Welding,* Vol. 2, Nov. 1938, pp. 58-63. Descriptive. The life of the molds used in the de Lavaud centrifugal pipe casting process has been increased by welding. Many molds of this type are being reclaimed by welding with heavy-coated electrodes. Preheating to 400° F. and continuous welding are of advantage because of the air-hardening characteristics of the steel of which the molds are composed. CEJ (6a)



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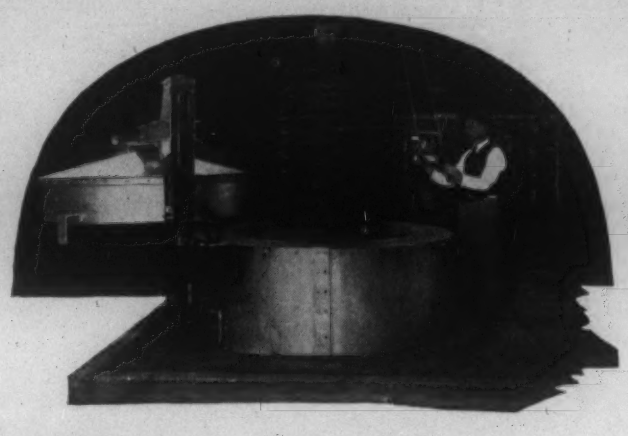

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6b. Non-Ferrous

Welding Thin Aluminum Sheet. E. NERRMANN. *Light Metals*, Vol. 1, Nov. 1938, pp. 348-350. Descriptive. A new method for the resistance welding of thin Al sheet is described, in which the heat is applied by a pair of portable and suitably mounted C electrodes. The sheet to be welded is flanged up with a C electrode at either side. As soon as the metal at the flange begins to run, the electrodes are drawn along the seam as rapidly as the metal melts. Ordinary speeds of welding vary from 500 to 600 mm./min. The only apparatus required is flux, the 2 C electrodes mounted at a small angle to each other in a suitable holder, and a transformer capable of delivering heavy amperages at small voltages. The capacity required varies from 200 to 3,500 watts and the customary voltage varies from 3 to 9. Photomicrographs are shown indicating the excellent bonding obtained with this type of weld. Tests have shown the welds to possess satisfactory physical properties and corrosion resistance. AUS (6b)

The Effect of Current, Pressure and Time on the Shear Strength and Structure of Spot Welds in the Aluminum Alloys. G. O. HOGLUND & G. S. BERNARD, JR. (Aluminum Co. of America) *Welding J., N. Y.*, Vol. 17, Nov. 1938, Suppl. pp. 45-54. The spot-welding characteristics of the Al alloys are quite different from those of many other materials. For the production of strong welds, careful choice of welding current is important; too low a current is the most frequent cause of weld failure in spot-welded Al construction. The production of strong welds with good appearance requires frequent dressing of the welding tips, and settings that produce more than 30 welds without "pickup" on the welding tips should be suspected of producing weak welds. Time of current dwell and electrode pressure must also be adjusted and controlled. CEJ (6b)

Welding, Brazing and Soldering of Light Metals (Schweiss- und Lötverfahren für Leichtmetalle) KARL HEINEMANN. *Tech. Blätter*, Sept. 25, 1938, pp. 568-570. Review. Considers the present status in this field in Germany, and discusses in detail procedures applied in these processes, including autogeneous welding, fluxes, suitable welding rods, electric resistance welding, C arc, metal arc and Arcatom welding, brazing, soldering and subsequent treatment of welds. GN (6b)

Riveting Methods and Rivet Equipment Used in the German Light Metal Aeroplane Construction. WILHELM PLEINES. *J. Roy. Aeronaut. Soc.*, Vol. 42, Sept. 1938, pp. 761-793. Discussion pp. 793-815. Exhaustive authoritative review. Covers: (1) Fundamental Notions on Riveting in Light Metal Aeroplane Construction. (2) Modern Methods of Riveting in Germany's Light Metal Aircraft Construction: (a) reasons accounting for the difference between riveting methods in aircraft construction and those of general engineering, (b) the different shapes of riveted joints in light metal aeroplane construction and their working methods. (3) Modern Riveting and Drilling Tools. (4) Machine Riveting. Among the 46 illustrations, diagrams show the effect of aging temperature on the changes of shearing stress of duralumin during 120 hrs., and also the age-hardening of 3 Al alloys mainly used for riveting purposes. A recently developed alloy analyzes: 2.08% Cu, 2.1% Mg, 0.8% Si, 0.55% Mn, 0.75% Fe, remainder Al. Contrary to American practice, a German material has been developed which is, in a freshly quenched condition, softer than duralumin, does not age at room temperature during the first 12-24 hrs. after quenching, and the ultimate shear stress of which is not reduced by more than 10% when aging is finished. For a 4-engined Junkers Ju 38, about 1 million rivets are required. Hollow rivets are not used in Germany because they are not as strong as solid ones. Where the hollow rivets require the strength of solid duralumin rivets, they are made of a Ni alloy. This material is corrosion-resisting and is Cd-coated to avoid galvanic attack at contact with Al alloys. Hollow rivets are unsuited to the transmission of high stresses. The problem of riveting structural parts accessible from one side only has not yet been completely solved. The latest development is the Heinkel explosive riveting method (Heinkel *Sprengnietverfahren)*. This rivet has a bore at the free-shaft end and is filled with a firmly pressed-in organic explosive that is non-corrosive in burnt or unburnt condition and that is protected by a coat of varnish. After ignition at 125° C. by an electrically heated tool having a Ag or Al head (not Cu), the free rivet shaft end swells to a barrel shape. The new riveting method is applicable to any material of more than 15% ultimate elongation. Rivet diameter: 2.6-6.0 mm. The execution of this novel type of riveting is described in full detail. A widely used alloy range contains 3.7-4.7% Cu, 0.4-1.0% Mg, 0.1-0.7% Si, 0.3-0.7% Mn, $<$ 0.5% Fe + Ti, $<$ 0.1% Zn and balance Al. EF (6b)

An Investigation of Arc and Gas Welded Joints in Aluminum and Aluminum Alloys. R. K. WELLS & A. G. BISSELL (U. S. Navy Dept.) *Welding J., N. Y.*, Vol. 17, Nov. 1938, Suppl. pp. 55-63. Original research. More than 60 specimens were welded, both with gas and the arc, and the materials under test were carefully analyzed and the test results recorded. Some difficulty was experienced in getting uniformly satisfactory results using the oxyacetylene process, but with oxyhydrogen, very consistent results were obtained. While joints of equal strength were produced in the vertical and flat positions by either gas process, satisfactory vertical welds were not obtained in this investigation using the arc. Al and its commercially available alloys are weldable, but care must be used in the application of welding and in the selection of the welding process. Welding of the complex, high-strength wrought alloys in the heavy sections tested did not produce joints as relatively satisfactory as obtained with the moderate-strength binary alloy, such as 3S. In all the alloys tested, arc welding gave better results than gas welding. CEJ (6b)

Copper Welding—A Résumé. W. C. SWIFT. *Ind. & Welding*, Vol. 2, Oct. 1938, pp. 49-52; Nov. 1938, pp. 50-52. Welding difficulties are encountered due to the high heat conductivity and to the presence of oxides in the Cu. The use of deoxidized Cu eliminates one of these troubles, while the use of a filler rod alloyed with some metal to reduce the temperature of fusion is helpful. A great deal of Cu is gas-welded with Si-bronze filler rods (96% Cu, 3% Si, and 1% Mn, Sn, Zn, or Fe). In Europe, large use is made of Cu filler rods alloyed with Ag, but these rods are quite expensive and the welds are no better than those made in America with deoxidized rods. The use of a long C arc with a 95% of parent metal strength and sufficient ductility to be folded P-bronze D high-P filler rod gives high speed welds with 90%-on themselves without cracking. CEJ (6b)

Copper and Copper Alloys. W. C. SWIFT (Compressed Ind. Gases, Inc.) *Welding Engr.*, Vol. 23, Dec. 1938, pp. 30-33. Practical. Suggests use of terms "bronze-welding" to describe any open "V" type joint, and "brazing" any joint where the base metals are closely fitted and the brazing metal is flowed between the proximate surfaces. The problem of supplying sufficient heat limits efficient gas welding to the smaller and medium size pieces of sheet and plate. Recommends the use of a long C arc, ¾-1¼ in., with high voltage and straight polarity. Best results are obtained with the use of a phosphor bronze D rod, with high Sn and P. CEJ (6b)

7·FINISHING

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

Galvanizing Practice and Galvanized Steel. E. J. GROOM. *Metallurgist (Suppl. Engineer),* Oct. 1938, pp. 162-164. Review. Most notable recent improvements have been in the organization and plant handling rather than in the metallurgy of galvanizing. Zinc-ammonium chloride is replacing ammonium chloride as a flux, but its superiority is not yet fully established. Convection-heating of the bath is believed to eliminate local overheating and therefore to diminish attack of the steel pot by the molten Zn and contamination of the bath with Fe. Pre-heating of the work not only increases pot life but reduces the thickness of the brittle Fe-Zn alloy layer. Of the common addition agents to Zn baths, small amounts of Sn or Sb—added to enhance spangle formation—are not detrimental to corrosion resistance or mechanical properties; Al—added to reduce viscosity and thereby increase pliability—may embrittle the coating if too much is present. Methods for improving corrosion resistance include treatment with S vapor, phosphates, Hg salts, oils or resins, chromates or molybdates. The last-named results in iridescent or dark brown films and may, like coppering, be a useful source of "eye-appeal." Little work has been done on types of finishing or priming coats most suitable for painting weathered or chemically roughened surfaces. In hot-dip galvanizing, heavy coatings offer maximum corrosion resistance. Electro-galvanizing offers certain advantages over hot-dip, but some of these—*e.g.* the feasibility of electrogalvanizing to any desired thickness—have not been widely applied. Electrogalvanizing does not always give a uniform structure. Although there is still some question as to the effect of the purity of the deposited metal on its corrosion resistance, some authors have published results indicating that purity and durability are insignificantly related, but that durability bears a straight-line relationship to thickness. 15 references. VVK + FPP (7)

7a. Electrolytic Methods

Some Recent Methods for the Determination of Pores in Zinc Coatings on Iron (Ueber einige neue Verfahren zum Nachweis von Undichtigkeiten in Zinküberzügen auf Eisen) GEORG GARRE. *Chem. Z.,* Vol. 62, Oct. 19, 1938, pp. 759-761. Review. For Fe coated with a nobler metal, such as Ni, Cr, Cu, etc., the ferroxyl indicator is mainly used or filter paper, soaked with potassium ferricyanide solution is applied. For the less noble Zn coatings, however, a new agent—potassium ferricyanide with additions of oxalic acid and H_2O_2—is recommended. Faulty spots in the coat (and also free Fe particles) cause a blue precipitation in the solution. Dilute potassium permanganate gives black discoloration. Increase in sensitivity and saving in time is obtained by using an electrolytic method. Potassium ferrocyanide is used in this case, and a strong electrolyte is added; the specimen is made the anode at 4v. Gas develops at faulty spots, which are later recognized by a blue deposit. Traces of Fe on the Zn surface do not react and cannot, therefore, be confused with pores. The method can be applied not only to Zn but to all coatings on Fe. RPS (7a)

Studies of Some Physico-chemical Factors in the Electrodeposition of Silver. SHRID HAR SARVOTTAM JOSHI & S. PADMANABHAN. *J. Ind. Chem. Soc.,* Vol. 15, Apr. 1938, pp. 176-190. Original research. Results are given for the best conditions for the production of smooth and adherent deposits of Ag. Data are given on the duration of electrolysis, interelectrode distance, concentration of electrolyte, temperature, current and the effect of addition agents, such as gelatine, turpentine and carbon disulphide. Measurements are made of the cathode efficiency of Ag in the presence of methyl alcohol, ethyl alcohol and acetone, the proportions of which were varied over a wide range. Curves correlating the above 2 quantities show marked discontinuities, which indicate a complex formation in the conducting medium. Data are also given for the conductivity, refractive index, density, transport number and viscosity. EF (7a)

Adherence of Electrodeposited Zinc to Aluminum Cathodes. H. R. HANLEY & C. Y. CLAYTON (Mo. School of Mines) *Metals Tech.,* Vol. 5, Oct. 1938, T.P. No. 983, 8 pp. Original research. The adherence of Zn coatings deposited from different electrolytes on Al sheet whose surface was varied was studied by measuring the pull required to strip the deposit. Although some impurities in the solution, which are plated with the Zn, may increase the load force required for the stripping of deposits, this feature is not regarded as pertinent to the subject of adherence because the purification system can prevent the presence of these objectionable substances. Impurities in solution that promote the dissolving of the deposited Zn in the acid electrolyte, as well as abnormal etching of the Al cathode, may be the starting point of adverse roughening of the Al plate. This roughened surface becomes more deeply etched and hastens the time when the Zn deposit tends to adhere more tightly. The partial cathodic Zn protection of the Al plate is not sufficient to prevent the development of the adverse surface. The Al plate that is the hardest develops adverse surfaces at the slowest rate. JLG (7a)

Modern Electrogalvanizing Processes (Neuzeitliche Verfahren der Elektroverzinkung) H. FISCHER & H. BAERMANN. *Korrosion u. Metallschutz,* Vol. 14, Oct./Nov. 1938, pp. 356-364. Review. Properties, advantages and disadvantages, especially in comparison with Cd coatings, of the currently-used Zn-plating methods are discussed exhaustively on the basis of literature and experiments. Bright-Zn plating methods are more economical (from the German point of view) than bright Ni and Cd plating processes, and fully equivalent in serviceability. Hard Zn deposits can be obtained with a Cu-containing alkaline Zn bath; such deposits lose their reflectivity by tarnishing much less than do brass, Ni or ordinary Zn coatings. High current densities, up to 5 amp./dm.^{2}, give Zn deposits equivalent to Cd in corrosion protection. Protection can be increased by subsequent treatment in a chromate bath. Hard-Zn depositing methods give less corrosion protection than the other Zn plating methods but these films can be used as a basis for Cr plating. 28 references. Ha (7a)

Activated Carbon in Electroplating Solutions. W. A. HELBIG. *Metal Ind., N. Y.,* Vol. 36, Dec. 1938, pp. 553-555. Excessive suspended matter, traces of lubricating oil, traces of organic matter from rubber tank linings, decomposition products from brightening and anti-pitting agents, etc., may cause trouble at the plating surface. These troublesome impurities can be removed by a combination of activated C treatment and filtration. The technique of precoating the filter medium with activated C is discussed. Activated C for use in electroplating solutions should be acid-washed, ground so that not over 60% will pass a 300 mesh sieve, and should have a high bulk density (apparent density of 0.40-0.45, equivalent to 25-28 lbs/ft.^{3}) CBJ (7a)

Effects of Sodium Cyanide, Sodium Carbonate and Rochelle Salt on the Cathode Efficiency of a Copper Electroplating Solution. ALBERT HIRSCH (Snyder Inc.) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 25, Nov. 1938, pp. 823-830. Original research. The addition of Na_2CO_3 or Rochelle salt to a copper cyanide bath increased the cathode current efficiency. As a result of the investigation, the following bath is suggested: NaCN, 50 g./l.; free NaCN, 15 g./l.; CuCN, 45 g./l.; Rochelle salt, 45 g./l.; Na_2CO_3, 45 g./l. At 55° C. and a current density of 0.4 amp./dm.^{2}, a good deposit is obtained with a cathode current efficiency of 95%. AB (7a)

Alkali Cleaners and Acids on Lead. GEORGE B. HOGABOOM. *Metal Cleaning Finishing,* Vol. 10, Nov. 1938, p. 740. Practical. Pb is attacked by alkali cleaners with the formation of a film upon which plated coatings do not adhere well. The following cleaning procedure is recommended: Clean the Pb in alkali without the use of current; scratch brush with a wire brush rotating below 850 r.p.m.; dip in clean alkali for a few seconds, then in 10% H_2SO_4; follow by a cyanide dip and plate in the cyanide Cu or brass bath. The current used should be 10-15 amp./ft.^{2} The gassing at higher current densities causes attack of the Pb. AB (7a)

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7b. Non-Electrolytic Methods

Submerged Heat. *Steel*, Vol. 103, Oct. 10, 1938, pp. 84, 86, 103. Industrial note describing automatic, submerged combustion system, (Submerged Combustion Co. of America, Hammond, Ind.), for heating and agitating pickling baths. When starting button is pressed a gas- and air-compressor is started which purges burner manifold and combustion chamber of solution that fills them. Simultaneously a hot-wire igniter is heated to incandescence and ignites pilot gas jet that is admitted into burner after a predetermined time. Main gas flow first is permitted to pass through system and then becomes ignited from pilot. Burner plate, located about 4 or 5 in. beneath solution level for cooling, directs flame through a tubular combustion chamber that conducts combustion products down to and across tank bottom where they may be vented and distributed to give rate of agitation desired. Thermostats actuate burner control mechanism and permit constant flow of air through solution, gas flow being turned on or off as heat requirements demand. This maintains a constant rate of agitation regardless of solution temperature or rate of heat input. Solution temperature can be controlled as close as ½° F. when necessary. The burner can be set to give any flue-gas analysis desired. The main advantage of the system is extreme agitation produced, which increases production rate. Average pickling time on various grades of steel will be 30-60% of former practice if operating temperature of bath with submerged combustion is the same as it was with steam. About 25-50% of acid added during life of solution can be saved. Total saving amounts to about 50% of present pickling costs. The system is flexible, and produces fewer rejects and a more uniform, higher quality product. MS (7b)

Piston Rings. *Steel*, Vol. 103, Nov. 28, 1938, pp. 50-51. Industrial note. New "Ferrox" process, developed by the Perfect Circle Co., Hagerstown, Ind., produces a black magnetic oxide surface on piston-rings for a depth of about 0.0005 in. [Involves heating at 1250° F. in an oxidizing atmosphere.] This surface serves to polish the cylinder wall and eliminate scuffing and scoring. Tests have shown that "Ferroxed" surfaces wear 40-90% slower, even when 50% greater pressures are applied against them. Treatment seems to be applicable to any Fe-bearing surface. MS (7b)

The Temperature Coefficient of the Acid Corrosion of Iron in the Presence of Organic Substances (Ueber den Temperaturkoeffizienten der Säuerekorrosion des Eisens bei Gegenwart organischer Stoffe) W. MACHU. *Korrosion u. Metallschutz*, Vol. 14, Oct./Nov. 1938, pp. 324-340. Review plus research, on the velocity of the chemical reaction in the dissolution of a heterogeneous system, *e.g.* corrosion of Fe in acids. The exhaustive tests show that the extremely high temperature coefficient of the corrosion of Fe in 20% H_2SO_4 is due exclusively to the convection effect of the liquid layer touching the metal. The temperature coefficient can be reduced considerably by suppressing the strong H evolution with an addition of organic inhibitors. The low temperature coefficient in the presence of organic substances results from the formation of a protective adsorbed layer of the inhibitor on the metal surface which makes the diffusion of acid to metal very difficult. The temperature coefficient of the corrosion of Fe *oxide*, however, is *not* affected by the presence of organic inhibitors, even at high concentration, since a protective layer can not be formed on the Fe oxide. The action of an inhibitor can be fully explained by this theory of diffusion velocity. 12 references. Ha (7b)

Attacking Trade Waste Problems. G. M. DARBY & C. L. KNOWLES (Dorr Co.) *Chem. & Met. Eng.*, Vol. 45, Oct. 1938, pp. 528-532. General survey, including discussion of waste from steel pickling operations. It is probably most economical merely to dump spent pickling liquor into streams, but inasmuch as this practice is widely forbidden for sanitation reasons, the problem becomes one of salvaging in order to defray as much as possible of the expense incurred in keeping the liquors from the streams. Crystallization of the ferrous sulphate for sale or conversion to a salable product is being studied. Liming, followed by flocculation, clarification and dewatering of the thickener underflow is also a possible answer. The Ferron process of treating pickling liquor with lime under controlled pH and temperature conditions to give a thick slurry, which is filter pressed, disintegrated and dried, provides a product claimed to be marketable as an insulation and building material. The recovery of iron oxide and sulphur or sulphuric acid is a logical technical answer. Steel plants requiring an immediate solution to the problem will probably find that neutralization and filtering requires the least expensive layout. PRK + FPP (7b)

Surface Protection of Zinc and Zinc Alloys by Chromate Coatings (Oberflächenschutz von Zink und Zinklegierungen durch Chromatüberzüge) H. FISCHER & N. BUDILOFF. *Korrosion u. Metallschutz*, Vol. 14, Oct./Nov. 1938, pp. 353-356. Practical. The properties of a chromate film produced on a Zn alloy by immersion in a suitable solution (MBV process) are discussed. The immersion period should be less than 60 secs., otherwise the coatings are loosened too much. Appearance and adherence do not change with increased bath temperature up to 45° C. A chromate film protects Zn and Zn alloys against corrosion in NaCl and H_2O_2 solutions, but in a continually renewed corrosive agent, *e.g.* salt-water spray, the protective action diminishes gradually as the film is destroyed. 6 references. Ha (7b)

Behavior of Different Kinds of Sulphuric Acid in Pickling Strip Steel (Das Verhalten verschiedener Schwefelsäuren in der Bandstahlbeizerei) W. UFER & A. DÖRING. *Stahl u. Eisen*, Vol. 58, Oct. 13, 1938, pp. 1107-1111. Practical. Laboratory and plant tests were made of chamber and contact process H_2SO_4 manufactured from different raw materials in determining the pickling activity of the different acids. With pure dilute acids without any additions, appreciable differences in the rate of attack and in acid consumption per ton of strip steel pickled were observed. Certain additions, such as NaCl, $NaNO_3$ and nitrosyl-sulphuric acid increased the differences between acids, but with a good grade of acid property diluted, these additions were not detrimental. Dilution to about 15% H_2SO_4 gave the best pickling results, the consumption being about 10-10.6 kg. of 96% H_2SO_4 per ton of strip steel. SE (7b)

Modern Pickling Practice. WALLACE G. IMHOFF (Wallace G. Imhoff Co.) *Metal Cleaning Finishing*, Vol. 10, Oct. 1938, pp. 668-672. Review. Pickle liquors become slow in action when they contain about 12-25% of $FeSO_4$. The disposal of spent liquors by running them into streams and rivers has created a serious pollution problem. The author reviews some of the proposed methods of disposing of spent liquors. These include treatment with lime, recovery of $FeSO_4$ by evaporation and spraying the solution into a furnace and condensing acid vapors. AB (7b)

Refinement of Ground Surfaces. H. S. INDGE (Norton Co.) *Mech. Eng.*, Vol. 60, Nov. 1938, pp. 807-812. Descriptive. Methods, processes and equipment to produce superfine finishes in the finishing of metal parts are described. The necessity of such refinement is warranted by the accuracy of dimensions required nowadays. Surface finishes are built up, a finer abrasive being used for each subsequent operation. Lapping and honing operations permit production of superfine surfaces at high speed and low cost. Ha (7b)

High Speed Galvanizing. *Steel,* Vol. 103, Dec. 19, 1938, pp. 62-63. Descriptive. Modern equipment for continuous galvanizing of steel sheets operates at 25-100 ft./min. Furnace design is an important factor in successful practice at these speeds. A set-up widely used on such installations utilizes the "impact" method of firing. Homogeneous air-gas mixture is directed at an angle into the interstices of a bed formed of refractory lumps piled loosely in combustion chamber. Very rapid and complete combustion takes place. Hot combustion products then pass over a bridge wall and come in contact first with upper portion of kettle. Then, by descending through passage between bridge wall and side of kettle, give up heat to kettle side walls until they pass to flue along bottom of setting. Heat transfer is by radiation, conduction and convection. Most of the heat is applied at top, with burners relatively high up on sides of setting. Kettle bottom is shielded from hot gases to provide a place where dross may settle and be undisturbed. Burners are distributed around 3 sides of the kettle at close intervals. Maximum fuel input is applied to end of kettle where sheets enter. No burners are used on exit end. Fuel control is automatic. Size of kettle is proportioned to permit maximum production rate desired with a conservative heat transfer rate through kettle walls. Where batteries of sheet galvanizing furnaces are used, it has been found useful to install a hot metal holding furnace and a Pb pot for preheating rolls for galvanizing machine. MS (7b)

Effect of Corrosion on the Durability of Paint Films. V. M. DARSEY (Parker Rust-Proof Co.) *Ind. Eng. Chem.,* Vol. 30, Oct. 1938, pp. 1147-1152. Practical. The durability of paint coatings applied to different metals depends, to a great extent, on the corrodibility of the base metal in the environment to which it is exposed. Chemical treatment of easily corrodible metals, to convert their surfaces to a more stable and less reactive phosphate coating, materially increases the durability of paint coatings. This treatment provides increased adhesion of paint film to metal and retards peeling or chipping away from abraded areas. Paint coatings containing a corrosion-inhibiting substance possess greater durability than similar paint coatings without an inhibitor. Most paint troubles have their beginning at the point of contact between paint and metal surface, and if a painting schedule is recommended, it is important that the treatment of the surface prior to painting be specified. 10 references. MEH (7b)

Looking Over the Porcelain Enameler's Shoulder. JOSEPH D. WALKER. *Metal Cleaning Finishing,* Vol. 10, Nov. 1938, pp. 750-758. Review. A clean metal surface is required for enameling. Castings are first sand blasted, the most efficient conditions being obtained with a 3/8 in. nozzle and 70-80 lb. air pressure. Oil and grease are cleaned from sheet metal by burning off in an annealing process, or by a hot alkaline bath. As a cleaner for surfaces that are to be enameled, the organic solvents are said to have some disadvantages compared with alkaline cleaners. The pieces are pickled 10-20 min. Absorption of H in the process sometimes causes blistering when the ware is enameled. After pickling, the ware is rinsed, dipped into a weak alkaline solution to neutralize traces of acid, and rapidly dried in a hot dryer. AB (7b)

Selection of Compounds for Automatic Buffing. WALTER R. MEYER. *Metal Ind., N. Y.,* Vol. 36, Dec. 1938, pp. 567-569. Practical. Functions of buffing compounds are: (1) To serve as a medium to transmit the pressure of the work against the wheel, or vice versa, for accomplishing cold-working and flow, and (2) to lubricate the wheel-metal interface by retarding oxidation of the metal, overheating of the buff and metal by excessive frictional heat, and to act as a medium for the removal of the solid products of buffing. Cost factors to be considered in testing buffing compounds include: (1) Cost of the compound per unit of buffed work, (2) cost of buffing wheel per unit of work, (3) labor and overhead per unit of work and (4) added or lowered cleaning costs. CBJ (7b)

Grinding and Polishing Fabricated Stainless Steel. C. A. CARLSON (Norton Co.) *Ind. & Welding,* Vol. 11, Oct. 1938, pp. 44-48. Practical. Stainless steels are finished by grinding and polishing to improve the resistance to tarnish and corrosion. As heat tinting takes place at 400° F., care must be taken to use free cutting grinding wheels and a plentiful supply of coolant or lubricant whenever possible. General information for grinding, polishing and buffing is included. The freedom of the finished surface from minute foreign particles and the complete removal of all spots, scratches, pit holes or even tiny imperfections decidedly influence the retention of the luster on any finished piece of stainless steel. CEJ (7b)

Modern Pickling Practice. WALLACE G. IMHOFF (Wallace G. Imhoff Co.) *Metal Cleaning Finishing,* Vol. 10, Nov. 1938, pp. 736-738. The author describes the development of acid-resisting materials for pickling tanks and their accessories and for sewers and drains used in the disposal of spent liquor. The principal materials used are alloys such as duriron, phosphor-bronze, and nickel alloys; acid proof brick; and rubber lined steel. AB (7b)

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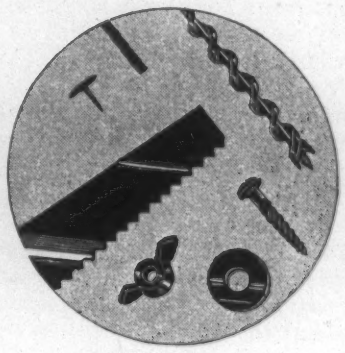

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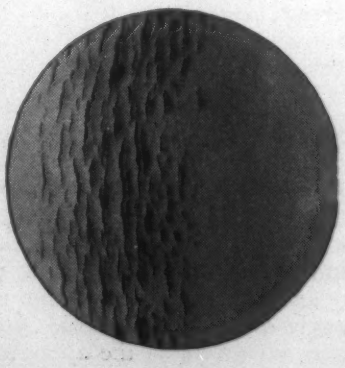

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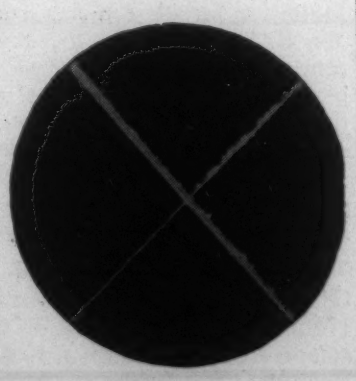

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8·TESTING AND CONTROL

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

Light Metal Tomography. H. W. GREENWOOD. *Light Metals,* Vol. 1, Dec. 1938, pp. 390-393. Review. Tomography is a division of radiography that deals with the photography of a particular plane in an object while leaving out undesired detail in other planes. While this technique was developed for medical radiography, it is recommended for certain purposes in work with metals where it is essential that the location of faults be exactly known. For example, if 2 cavities are present in a casting, one below the other in line with the X-ray target, there is no way of determining, in one picture, which lies above the other. Furthermore, in many instances confusion would exist as to whether or not the pattern on the film were due to one complex cavity or 2 or more cavities whose images were superimposed on the film. The tomograph is an X-ray machine rigged so that the film and X-ray tube are fixed to opposite ends of a beam or bar. This member is pivoted at a point so that the elevation of the pivot corresponds to the elevation of the plane in the object that is to be photographed. The tube and film move back and forth, with the object between, in planes parallel to the plane of the film. In effect, the tube and film holder constitute the ends of an oscillating pendulum. But these ends, as stated above, do not describe arcs, but move linearly. From simple geometrical considerations it is readily apparent that points in the pivotal plane will be projected as points on the film, but points in other planes will be projected as lines; the length of the lines, of course, vary with the distance from the pivotal plane (photographed plane). Hence, points at distances of over about ¼ in. from the desired plane will be considerably blurred, showing up clearly, in contrast, the sharpness of points in the desired (pivotal) plane. AUS (T-8)

Effect of an Elastic Anisotropy on the X-ray Measurement of Stresses (Einfluss einer elastischen Anisotropie auf die röntgenographische Messung von Spannungen) R. GLOCKER. *Z. tech. Physik,* Vol. 19, Oct. 1938, pp. 289-293. Theoretical. The elastic anisotropy of polycrystalline Fe to be expected in the X-ray measurement of strains is calculated on the assumption that the individual crystallites of a metal deform independently of each other. It is found to be much greater and to vary with the angle of incidence of the X-ray beam in quite a different manner than according to the approximate calculation of Möller & Barbers (*Metals and Alloys,* Vol. 7, Mar. 1936, p. MA 138 R/2). Comparison with the X-ray measurements of the above authors and of Möller & Strunk (*Metals and Alloys,* Vol. 9, Sept. 1938, p. MA 566 R/5) shows that the newly calculated values of elastic anisotropy are much too high, proving that the assumption of an independent deformation of the individual crystallites is incorrect. At the present-day accuracy of X-ray measurements of individual stresses at an angle of incidence of 45°, the effect of the elastic anisotropy may be disregarded, so that the technical values of the modulus of elasticity and the Poisson number can be used safely in evaluating the results of X-ray measurements. ORS (T-8)

Influence of the Speed of the Testing Machine on the Observed Mechanical Properties of Certain Austenitic Steels (Influenza della velocita di trazione sulle propieta meccaniche di alcuni acciai austenitici) I. MUSATTI & E. HUGONY. *Met. Ital.,* Vol. 30, Oct. 1938, pp. 545-564. Original research. The effect of varying the speed of the testing machine from 0.5 to 90 mm./min. on the observed tensile and elongation values of several austenitic and ferritic Cr-Ni steels was investigated. Samples containing 8.50-31.96% Ni; 8.35-26.62% Cr, were compared. Austenitic steels whose compositions were close to the line separating the martensite and ferrite areas of the structural diagram showed a decrease in tensile and elongation as the speed of testing increased, a phenomenon not shown by steels whose composition was well inside the austenitic area. Austenitic steels containing Mn, on the contrary, show increasing tensile and elongation as the speed of the testing machine is increased. Ferritic steels do not appear to be influenced greatly either way. AWC (T-8)

Sound as an Aid to Research (Der Klang als Forschungsmittel) FRITZ FÖRSTER. *Umschau,* Vol. 42, Nov. 6, 1938, pp. 1025-1029. Up-to-date review. The damping of sound in a specimen is strongly influenced by flaws in the material. If an oscillating body has a crack, the adjacent planes in the crack rub against each other, so that the oscillation energy is transformed to friction heat. Different materials have different damping characteristics. There is a simple relationship between the natural frequency and the modulus of elasticity of a material. Both damping and the modulus of elasticity can be determined easily by means of sound. Curves of resonance, *i.e.* amplitude against frequency, are plotted. A wide curve corresponds to strong damping and vice versa. The specimen can be mounted in a furnace or in a cooling tank during the test. Almost all metallographic changes (transformation, change in distribution, recrystallization, grain growth, change in plastic behavior, magnetic changes, etc.) show up in the sound characteristics. Internal stresses are even more evident in the sound properties than are transformations. The beneficial effect of working on sintered alloys, especially the increasing density, can be closely watched by this method. The hardening process can be controlled and intercrystalline corrosion detected. It is emphasized that the specimen is not subject to any stress during testing. With a single exception (ferromagnetic materials), damping is a well defined physical constant. RPS (T-8)

An Investigation of Notch Effect in Static Tests (Die Untersuchung von Kerbwirkungen im statischen Belastungsversuch) W. SPÄTH. *Metallwirtschaft,* Vol. 17, Oct. 28, 1938, pp. 1133-1134. Discussion. Several factors are mentioned that should be considered in evaluating the results obtained from notched tensile specimens. Effects such as (a) stress concentration caused by the notch effect, (b) decrease in the relative elongation of a gage length that is considerably greater than the amount of material deforming, and (c) the influence on the tensile strength of the essentially higher rate of deformation at the notch base should be differentiated. GA (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

X-ray Determination of the Change in Distribution of Internal Stresses During Alternating Bending Tests (Röntgenographische Bestimmungen der zeitlichen Änderung des Eigenspannungszustandes bei Biegewechselbeanspruchung) F. GISEN & R. GLOCKER. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 297-298. Experimental. An X-ray investigation was made of the stresses about a hole bored horizontally through a cylindrical endurance (bending) specimen. The samples had been cold worked parallel to the cross section of the hole. Before testing compression stresses were present in the regions that had been cold worked during preparation of the sample, and both compression and tensile stresses were present in other regions. After testing near the endurance limit, the specimen seemed to be covered with a "skin of compression stresses." GD (8a)

Critical Review of Recent and Important Endurance Tests on Aluminum Forging Alloys (Kritische Zusammenstellung der neuesten und wichtigsten Dauerfestigkeitsuntersuchungen von Aluminium-Knetlegierungen) H. WESTHOFF. *Z. Metallkunde,* Vol. 30, Aug. 1938, pp. 258-265. A careful review of the literature leads to the conclusion that values for endurance strength cannot be evaluated except for a specific number of cycles, and that tests involving a large number of alternations are still incomplete. Bibliography attached. GDC (8a)

The Fatigue of Metals. YOICHI KIDANI. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1042-1052. In English. Original research. A statistical theory of fatigue is developed. The fatigue of metals with repeated eccentric loading is classified in 2 groups, that occurring in a quasi-elastic region, and that occurring in the plastic region. The properties of internal friction of metals for quasi-elastic and plastic repetition in torsion is mathematically treated. A table presents the values of fatigue limits (torsional stress) for 3 steels, Ni, Cu, bronze, Al and magnalium. Experimental data obtained on cylindrical specimens of 0.6%, 0.3%, 0.1% C steel and Cu tested in the Kuraishi-Kuno repeated torsion machine under severe torsional stresses are in excellent agreement with the author's theoretical formula which, in turn, agree with the Dalby-Stromeyer equation $S = F + C (10^6/N_F)^{1/4}$, where S is a given stress, F is fatigue limit when N_F = infinity, C is a constant (the slope of the line obtained by plotting S for a given specimen against N_F, the number of cycles to failure. EF (8a)

Oscillating Stresses and Crystal State (Wechselbeanspruchung und Kristallzustand) H. MÖLLER & M. HEMPEL. *Mitt. Kaiser-Wilhelm Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 17, 1938, pp. 229-238. Research. Crystal behavior and the possibility of deformation at fatigue fracture were further investigated and, in general, results of previous investigations were corroborated (see also *Metals and Alloys,* Vol. 9, Aug. 1938, p. MA 498R/8). The strong disturbances of the crystal lattice associated with fatigue fracture were always observed only in the completely fractured specimen and cannot, therefore, be considered as a cause of fracture but must be considered as an accompanying phenomenon. The tests are described in detail, and X-ray pictures show the progress of the structural change after every few hundred-thousand cycles during the fatigue test. Ha (8a)

Distinction between the Crystalline Mechanism of Static and Dynamic Rupture (Distinction entre le Mécanism Cristalline de la Rupture Statique et celui de la Rupture Dynamique) G. A. HOMES & P. DUREZ. *Bull. Classe Sciences Acad. Roy. Belgique,* Vol. 24, Ser. 5 (3), 1938, pp. 159-162. Original research. Whereas the static or instantaneous fracture is characterized by the progressive deformation of all the crystals, the dynamic or fatigue fracture is due to the progressive deformation of only some of the crystals. It is highly possible that a repetition of stresses simply accentuates the initial differences between the strength of the individual crystals. EF (8a)

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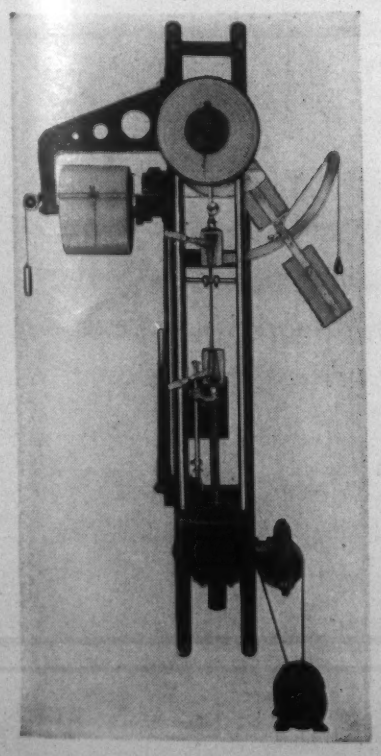

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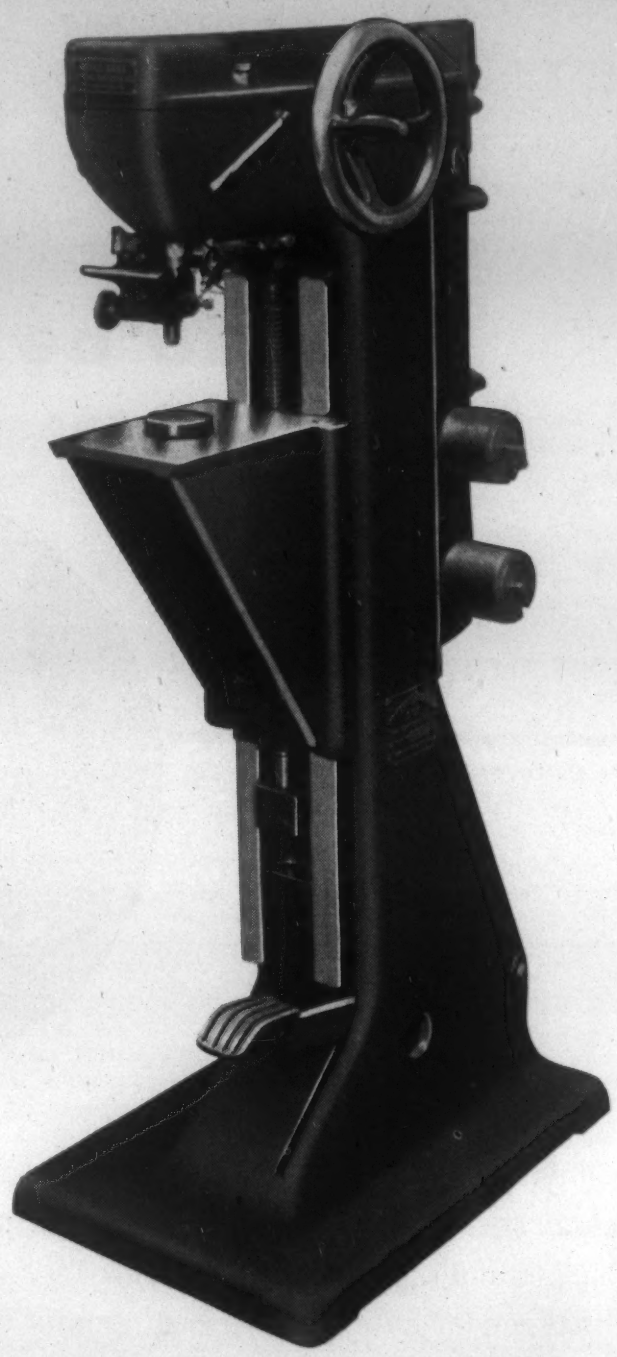

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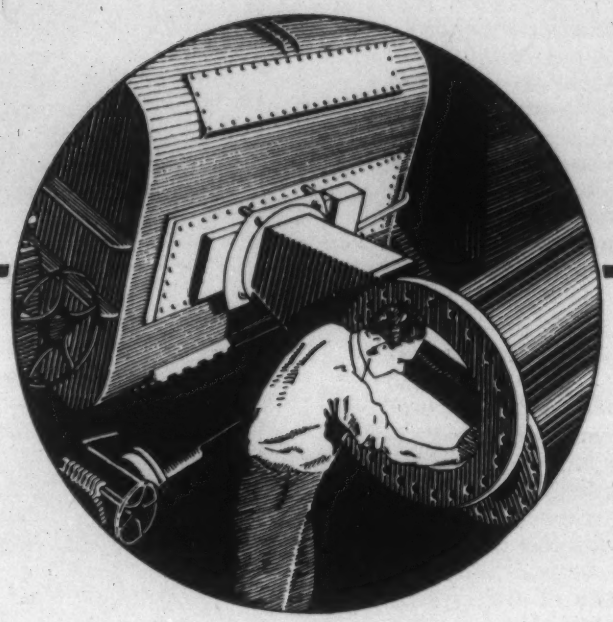

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9 · METALLOGRAPHY

Structure and Constitution.

J. S. MARSH, SECTION EDITOR

Technique and Possibilities of Microradiography (Technique et Possibilités de la Microradiographie) F. FOURNIER. *Rev. Mét.*, Vol. 35, Aug. 1938, pp. 349-356. Original research. The use of X-rays for examination of the heterogeneity of alloys was impeded by the difficulty of obtaining a film sensitive enough to X-rays and yet so fine grained that it could be examined under the microscope. The Lippmann-Gevaert emulsion is satisfactory and may be examined at 200 X. This method of examination is particularly suited to the light alloys, where there is a considerable difference in atomic number between the constituents. Comparative microradiographs and photomicrographs show the ability of the former to delineate clearly heterogeneities in solid solutions, etc. While the microradiographs are not so valuable for ferrous alloys, they do indicate impurities, cracks, heterogeneities, and micro-inclusions. JZB (9)

The Crystal Structure of Co_2Al_5. A. J. BRADLEY & C. S. CHENG. *Z. Krist.*, Vol. 99, Aug. 1938, pp. 480-487. In English. Original research. The structure of Co_2Al_5 was determined from X-ray powder photographs with the help of the structure factor graphs and figure fields. The unit cell is hexagonal with a = 7.593 A.U. and c = 7.656 A.U. It contains 8 Co atoms and 20 Al atoms. The space group is D^4_{6h}, C 6/mmc. Perpendicular to the hexagonal axis, the atoms are near 4 equidistant planes, each containing 7 atoms. One of the atoms lies on a 3-fold axis, the other 6 grouped around in a symmetrical fashion. EF (9)

9a. Ferrous

J. S. MARSH, SECTION EDITOR

Kinetics of the Decomposition of Austenite at Constant Temperature. J. B. AUSTIN & R. L. RICKETT (U. S. Steel Corp.) *Metals Tech.*, Vol. 5, Sept. 1938, T.P. No. 964, 20 pp. Mathematical. Measurements of the rate of decomposition of austenite at constant temperature can be made to plot on a straight line if time is plotted on a log. scale and % transformed is plotted on either the "autocatalytic" or the "integrated-probability" scale. The straight-line plot permits easy and rapid interpolation and also permits extrapolation to 1% and 99% transformation. The isothermal rates for a given steel plotted in this manner have the same slope over the temperature range in which austenite transforms to "bainite." Moreover, within this range the time required for completion of a given fraction of the transformation varies inversely with the absolute temperature; that is, $\log t = \frac{a}{T} + b$. For a given steel the constant "a" is independent of the fraction chosen, so that lines representing 1% and 99% are parallel. Below 250° C. the isothermal rate curves show 2 steps instead of one. The rate at which the second reaction goes on is also represented by a straight line on the "log-autocatalytic" or "log-probability" paper. The log of the time required for completion of a given fraction of transformation varies inversely with the absolute temperature, but the lines for different percentage transformations do not have the same slope. There appear to be 2 reactions taking place below 200° C. The first is probably the formation of martensite, but the nature of the second is not known. JLG (9a)

The Constitution of Vanadium Carbide (Étude de la Constitution du Carbure de Vanadium) ANDRÉ MORETTE. *Bull. Soc. Chim.*, Vol. 5, Sect. 5, July 1938, pp. 1063-1069. Original research. Previous literature is summarized, showing that various investigators assume the existence of CV, C_3V_4, CV_5 and CV_2. Mixtures of vanadic anhydride and sugar charcoal were heated in a Moissan arc furnace and alloys containing 7.3-26.6% C by analysis were obtained. In the presence of an excess of C, a compound corresponding to the formula C_3V_4 forms at elevated temperatures. This result has been verified by a metallographic and X-ray analysis. C_3V_4 is face-centered cubic (a = 4.15 A.U.), as is metallic V. EF (9a)

Extraction of Oxide Inclusions in High Carbon Iron-Electrolytic Iodine Method. FRANK W. SCOTT (Univ. Minn.) *Metals and Alloys*, Vol. 9, July 1938, pp. 171-174; Aug. 1938, pp. 201-206. Original work on the effect of the presence of metalloids on the recovery of oxides by the electrolytic iodine method. An extensive review of the literature and methods of separating oxide and other non-metallics from steel is given. The experimental work consisted of the extraction of a number of pig irons and specially prepared melts of hypereutectic Fe-C alloys with varying metalloid content. These special melts were made from Armco iron, C, and ferroalloys to yield the composition desired. Previous work has indicated only a slight solution of oxides in this method. The author states that loss of Mn silicate is negligible when the silicate is over 50% SiO_2, though the data from which this conclusion is drawn are not shown clearly. 40 references. WLC (9a)

Investigation of the $\alpha \rightleftarrows \gamma$ Transformation and of the Properties of the α-phase of the Fe-Ni-Si System. O. N. AL'TGAUSEN. *Metallurg*, Vol. 13, Mar. 1938, pp. 3-14. In Russian. Original research. With 0-10% Ni the addition of Si raises the temperature of $\alpha \rightleftarrows \gamma$ changes; with over 10% Ni the addition of Si expands the α plus γ field and lowers the temperature of the beginning and end of $\gamma \rightarrow \alpha$ change. Up to 10% Ni the magnetic saturation increases slightly or remains stationary, but when Ni is increased to above 10% the saturation drops. Presence of Si lowers the saturation value. At a constant Si content, the addition of Ni increases the coercive force in the region where there is a $\alpha \rightleftarrows \gamma$ transformation. Alloys of over 4% Si have a lower coercive value than the others. BZK (9a)

Mechanism of Cementite Dissociation During Graphitization of Pig Iron. E. G. SHUMOVSKII & A. V. ORLOV. *Metallurg*, Vol. 13, Jan. 1938, pp. 25-38. In Russian. Original research. The dynamics of secondary graphitization were observed in a vacuum furnace. Observations lead to the conclusion that transformation mechanism occurs as follows: Under the extended influence of near-eutectoid temperature, the eutectoid cementite tends to assume a globular form which facilitates its solution in the austenite. The small particles of cementite continue to dissolve in the austenite while the larger ones of primary graphite will continue to grow. An attempt is made to support this with the theory of Piwowarsky. The effect of vacuum is to decrease the speed of secondary graphitization. BZK (9a)

The System Iron-Columbium (Das System Eisen-Niob) R. VOGEL & R. ERGANG. *Arch. Eisenhüttenw.*, Vol. 12, Sept. 1938, pp. 155-156. Research. The Fe-Cb diagram was determined thermally and microscopically. The compound Fe_3Cb_2 at 50% Cb, m.p. 1650° C. divides the diagram into 2 eutectic regions, the one at the left occurring at 21% Cb, m.p. 1360° C., and the the one at the right at 73% Cb, m.p. 1515° C. α Fe dissolves about 5% Cb at the 1360° C. eutectic temperature. At 1100° C., the solubility is about 3%, and decreases very little as the temperature goes down. The change in solubility leads to only a small age hardening effect; an increase in hardness after an age-hardening heat treatment from 143 Brinell to 229 Brinell was observed. SE (9a)

Age-toughening of Mild Steel. I. HAGIHARA. *Nippon Kinzoku Gakukai-Si*, Vol. 2, Aug. 1938, pp. 409-413. In Japanese. Original research. Properties of mild steel quenched from above the transformation temperature were varied by aging. The storage (or room-temperature aging) of quenched steel caused a considerable increase in elongation and a reduction in area without an appreciable change in tensile strength. H analysis indicated that the age-toughening phenomenon is due to liberation of H_2, which is absorbed from moist atmosphere during heating in the electric furnace. NS (9a)

The Conversion of Solid Cementite into Iron and Graphite. H. A. SCHWARTZ. *J. Iron Steel Inst.*, Advance Copy No. 14, Oct. 1938, 31 pp. Up-to-date review. The graphitizing action is discussed in light of thermodynamical data and direct experimental evidence. Both the author's own work and other pertinent literature is critically considered in explaining the behavior of Fe during graphitization. 64 references. JLG (9a)

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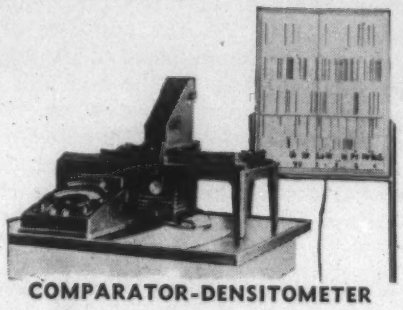

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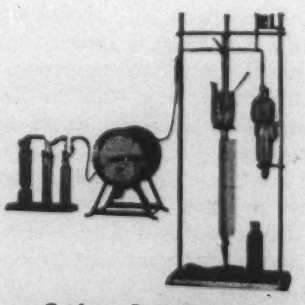

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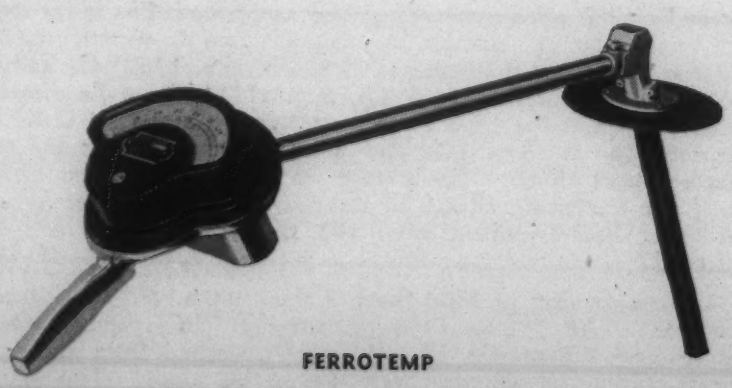

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9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

An X-ray Study of Dental Amalgams. ALEXANDER R. TROIANO (Harvard Univ.) *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 811, 13 pp. Original research. X-ray diffraction studies were made on amalgams prepared by trituration of Ag_3Sn with Hg, and directly from the elements Ag and Sn with Hg. In general, the equilibrium diagram of Gayler is confirmed, but the theory of setting advanced by her is not consistent with the experimental results. An alternative theory of setting divides the reaction into 2 parts: (1) $Ag_3Sn + Hg \rightarrow \gamma_1 + \delta_2 + Ag_3Sh$ (unattacked), which completes the reaction between solid and liquid and terminates the actual "hardening" reaction. Subsequently, the alloy should tend to approach equilibrium by: (2) $\gamma_1 + \delta_2 + Ag_3Sn$ (unattacked) $\rightarrow \gamma_1 + \gamma_2 \rightarrow \gamma_1 + \gamma_2 + \beta$. After at least 15 days at room temperature, no indication of this latter reaction could be detected. Since the dimensional changes observed immediately after setting are all complete in a few days, the equilibrium reaction can play no part in them. Hence, the explanation by Gayler that contraction may be caused by the formation of β_1 cannot be correct. It is proposed that the expansion be explained by the dendritic growth of the γ_1 phase from the melt, with the subsequent production of voids. Contraction may be explained by the precipitation of δ_2 in the interstices of the dendrites, which would tend to eliminate the voids. Analogy is made to the peritectic reaction. JLG (9b)

Rates of Diffusion of Copper and Zinc in Alpha Brass. ERNEST KIRKENDALL, LARS THOMASSEN & CLAIR UPTHEGROVE (Univ. of Mich.) *Metals Tech.,* Vol. 5, Oct. 1938, T.P. No. 967, 18 pp. Original research. Diffusion was studied by plating Cu on β brass, heating to allow diffusion to take place, and measuring the concentration of Cu by determining the lattice constant of the alloy. Three diffusion coefficients were determined at 3 different temperatures on substantially the same α brass. From the results, it is possible to calculate the probable rate of diffusion in this α brass at any temperature below the melting point, by means of either of 2 equations. The method used made it possible to eliminate any uncertainties concerning the variation of rates of diffusion with concentration, as well as those concerning the superficial area of a porous surface. The diffusion coefficients in cm.^{2}/sec. were 8.6×10^{-11} at 600° C. and 28.3% Zn, 3.54×10^{-10} at 655° C. and 26.8% Zn, and 1.31×10^{-9} at 720° C. and 25.3% Zn. These rates of diffusion fit the generally accepted equation $D = Ae^{-Q/RT}$, which shows the effect of temperature on diffusion. The value of Q in this equation was found to be 39,000 cal./g.-atom. The substitution of any of the diffusion coefficients above in the empirical equation $D = (Q/Nh)\delta^2 e^{-Q/RT}$ gives a value Q of about 38,000 cal./g.-atom, which is in exceptional agreement with the value of Q above. JLG (9b)

X-ray Study of the Cobalt-sulfur System (Röntgenuntersuchung des Systems Co-S) D. LUNDQUIST & A. WESTGREN. *Z. anorg. allgem. Chem.,* Vol. 239, Aug. 12, 1938, pp. 85-88. X-ray diffraction research. A complete analysis of the system Co-S was undertaken to clear up some existing disagreements. The following compounds were confirmed: Co_9S_8, CoS, Co_3S_4 and CoS_2. For Co_9S_8, a cube edge of 9.907 A.U. was found. The compound CoS resembles FeS in that its lattice contracts on adding S, but to a much less extent; its structure, of the NiAs type, has the dimensions a = 3.367, c = 5.177 A.U. or a = 3.361, c = 5.160 A.U., depending on whether the phase is saturated with Co or S. The homogeneity range of CoS at 650° C. is from 51 to 53 atomic % S. No superstructure lines were found. All alloys in the range 54-66 atomic % S show lines of a phase Co_3S_4, which is face-centered cubic, a = 9.382 A.U. The structure of the compound CoS_2 was that found by DeJong and Willems, but with a slightly smaller parameter, a = 5.524 A.U. For earlier work see also *Metals and Alloys,* Vol. 8, May 1937, p. MA 296 R/7. HFK (9b)

The Growth of Magnesium Crystal in its Vapor. SEITA SAKUKI. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1131-1146. In English. Original research. Frequent reference is made to experiments by Straumanis (see *Metals and Alloys,* Vol. 3, May 1932, p. MA 126 R/2; Vol. 6, Apr. 1935, p. MA 164 R/2). The object of this study was to obtain Mg crystals as large as possible. The author studied the effect of temperature, pressure, time, Fe sheet carriers, asbestos wool, kind of gas (air, sulphurous acid, H) size of sublimation surface, longitudinal distribution of temperature, etc. Mg crystals grow most rapidly to a regular form in Mg vapor at the highest possible temperature (below the melting point) in the densest possible vapor and at a moderate reduction of pressure of 0.80-2.70 mm. Hg. X-ray investigation of the large crystals shows many crystals of mosaic structure. The large crystal faces had the indices of (0001) or (10-10). The crystal faces having the indices (10-11) were generally of small area. EF (9b)

The Rate of Viscous Flow of Metals: Part I, Tin. L. C. TYTE. *Proc. Physical Soc., London,* Vol. 50, Mar. 1938, pp. 153-175, discussion pp. 311-312. Research on wires. Determinations are reported of the "constant" rate of flow reached after 15-20 min. when loads up to 2,000 lbs./in.^{2} were applied to Sn wires (purity and grain size unspecified) at temperatures from 19° to 207° C. Exponential relationships between this "velocity of viscous flow," the stretching load and the absolute temperature are developed in detail. The results are held to confirm that the allotropic modification from β to γ Sn occurs at 203° C. rather than 161° C.; and that there is a transition in the nature of deformation from single to double glide at a stress which varies with temperatures according to a hyperbolic law. [The involved mathematical treatment would be more convincing if the experimental data were more complete. "Creep" tests carried out for 20 min. may be easy to observe but should not be extrapolated.—J. C. C.]

JCC (9b)

The Diffraction of X-rays by an Age-hardening Alloy of Aluminium and Copper. G. D. PRESTON. *Phil. Mag.,* Vol. 26, Nov. 1938, Suppl. pp. 855-871. Original research. The changes observed in the X-ray spectrum at different stages of age-hardening at room temperature and at 200° C. were sought to be related to the hardness of the metal. Photographs of the different stages are reproduced, and the structures are analyzed on this basis. The structure seems to be tetragonal with a = 5.71 A.U., c = 1.015 A.U., and contains 4 Cu and 8 Al atoms, *i.e.* 4 molecules of $CuAl_2$; this structure differs, however, from that of $CuAl_2$ as usually obtained. It could not be established whether this is a metastable intermediate phase or the stable form of $CuAl_2$ at low temperatures; the new crystals are closely united to the Al lattice.

Ha (9b)

An X-ray Study of the Superlattice in Certain Alloys. E. A. OWEN & I. G. EDMUNDS. *Proc. Roy. Soc. London,* Vol. 50, May 1938, pp. 389-397. Original research. The X-ray structure of 50:50 atomic % Ag-Zn alloys shows a strong ordered arrangement (superlattice) when a sample, quenched from above 300° C., is examined at room temperature. Strangely enough, when the sample is examined at 300° C. the superlattice is not found. This unexpected behavior is not shown by the Au-Zn alloys, which retain their superlattice at all temperatures up to the melting point. In the Ag-Zn alloys an ordered arrangement must exist at high temperatures, but it is of a type that cannot be detected by X-rays.

JCC (9b)

The Equilibrium Diagram of the Cu-Sb System. Fourth Report: An X-ray Investigation of Cu-Sb Alloys. A. OSAWA & N. SHIBATA. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Oct. 1938, pp. 502-510. In Japanese. Original research. X-ray analyses and specific gravity measurements of all the phases in this alloy system were carried out.

Phase	Crystal Class	Lattice Constants, A.U. a	Lattice Constants, A.U. c	Specific Gravity
α (100-95.3% Cu)	F. C. C.	3.6079_2	3.6413	$8.92–8.54_2$
β (Cu_5Sb_2)	B. C. T.	9.01_4	8.57_4	8.9
γ (Cu_2Sb)	Simple T.....	5.62_1	6.07_4	8.446
δ (Cu_9Sb_2)	Hex.	10.836	8.611	8.878
η ($Cu_{11}Sb_2$)	Orthorhom. ...	9.28_5	8.62_9	8.909
θ ($Cu_{11}Sb_4$)	Hex.	5.494	8,686	8.617
ϵ Sb	Hex.	4.290	11.237	6.68

NS (9b)

The Surface Structure of Liquid Mercury. G. L. J. BAILEY, S. FORDHAM & J. T. TYSON. *Proc. Physical Soc., London,* Vol. 50, Jan. 1938, pp. 63-69. Includes discussion. Original research. Electron diffraction measurements always show a thin crystalline film on the surface of liquid Hg. This, however, is not a Hg structure; it is due to a scum impurity which it has so far been impossible to eliminate. The surface film cannot be Hg, for it prevents evaporation in vacuum, protects an evaporated Au layer from attack until the skin is broken by agitating the Hg, and acts as a barrier against oxidation of Hg by ozone. JCC (9b)

The Chromium-phosphorus System (Untersuchungen im System Cr-P) H. NOWOTNY & E. HENGLEIN. *Z. anorg. allgem. Chem.,* Vol. 239, Aug. 12, 1938, pp. 14-16. Experimental. X-ray diffraction studies were made on the Cr-P system up to 50 atomic % P. Two compounds, Cr_3P and CrP, were found. Cr_3P, which is isomorphous to Fe_3P (group S_4^2), is tetragonal, a = 9.126 A.U., c = 4.560 A.U. It is weakly ferromagnetic. CrP is isomorphous to MnP (group D_{2h}^{16}) and has a NiAs structure, with a = 5.93, b = 5.35 and c = 3.12 A.U. It is non-ferromagnetic.

HFK (9b)

Crystal Structure of Ni_3S_2 (Die Kristallstruktur von Ni_3S_2) A. WESTGREN. *Z. anorg. allgem. Chem.,* Vol. 239, Aug. 12, 1938, pp. 82-84. Experimental. The crystal structure of Ni_3S_2 has been determined completely. It is rhombohedral, space group D_3^7, a = 4.041 A., α = 90.3° and thus almost cubic. The cell contains 1 Ni_3S_2 group, the S atoms occupying the positions of a body-centered cubic structure with the Ni atoms filling in at ½ y y, y ½ y and y y ½.

HFK (9b)

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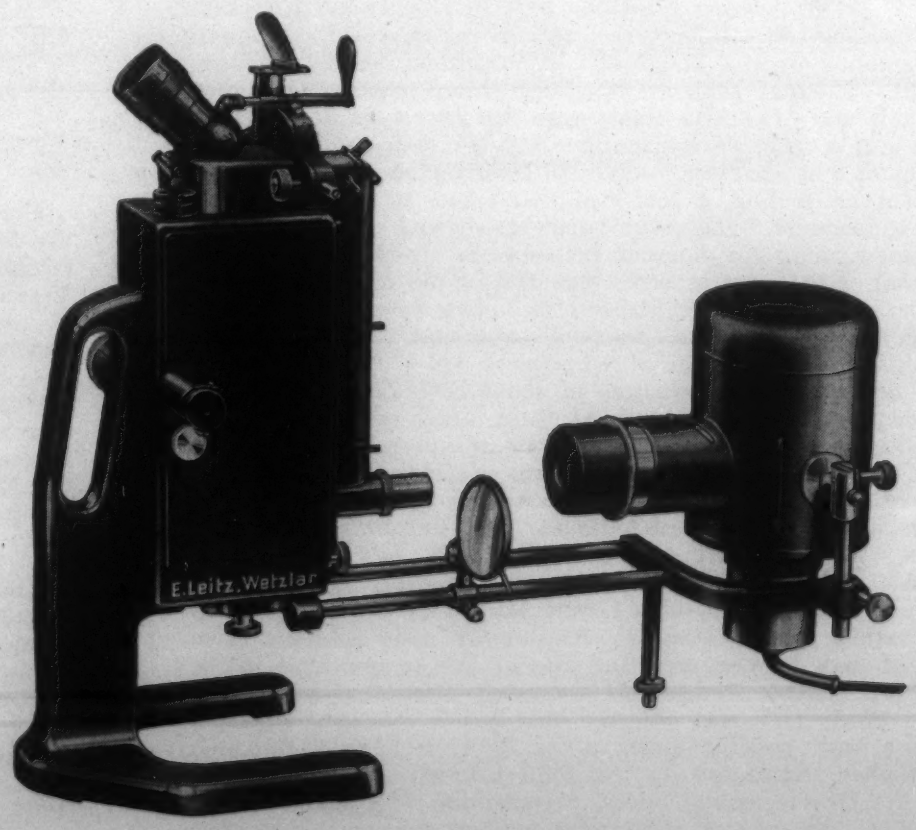

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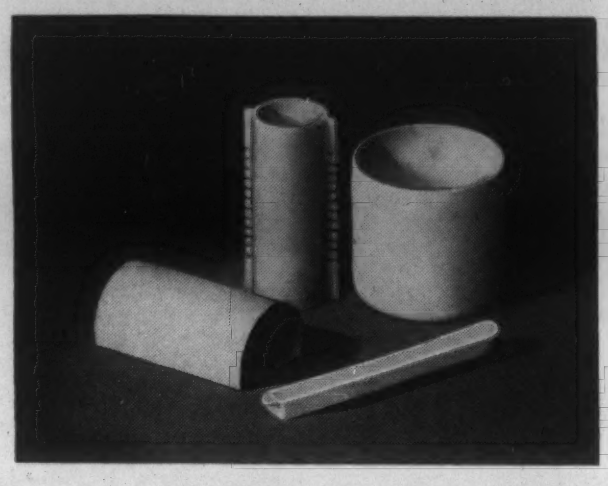

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The Constitution of Aluminum-zinc Alloys of High Purity: The Nature of the Thermal Change at 443° C. MARIE L. V. GAYLER & E. G. SOUTHERLAND (Natl. Phys. Lab.) *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 813, 15 pp. Original research. The liquidus and solidus curves of high-purity Al-Zn alloys were redetermined over a range of composition of 40-100% Zn by weight. Thermal analyses of alloys stirred continuously show definitely that: (a) The heat change that occurs on heating takes place over a range of temperature; (b) the temperature at which maximum heat absorption occurs falls with increasing Zn content: and (c) on cooling, a heat evolution occurs at very nearly constant temperature. Microscopic analyses showed: (a) No primary separation along the liquidus between the melting point of Al and that of the eutectic, other than that of the Al solid solution; (b) no evidence of the existence of a 2-phase field above 360° C.; and (c) no evidence of a "reaction" compound. The heat change that occurs over the range of temperature 440-470° C. was shown to be due to a marked change—of about 12% Zn by weight—in the composition of the primary Al phase, which takes place during solidification over a very small temperature interval, approximately 12° C. A revised equilibrium diagram is given. JLG (9b)

X-ray Analysis of the System Arsenic-antimony (Röntgenanalyse des Systems Arsen-Antimon) W. TRZEBIATOWSKI & E. BRYAK. *Z. anorg. allgem. Chem.,* Vol. 238, July 1, 1938, pp. 255-267. Experimental. 20 vacuum-melted alloys of As-Sb and 2 natural alloys (Allemontite) were studied by X-ray diffraction after various heat treatments. A complete solid solution series exists at high temperatures, and also at low temperatures in the range 0-25 atomic % As. In the range 25-46 3 atomic % As a new phase (β) was observed that has a face-centered cubic structure with possibly either $a_0 = 5.54$ A.U. or 11.06 A.U. The β-phase transforms to the solid solution on tempering at 550° C. Of the natural alloys, 1 containing 53.3 atomic % As showed a homogeneous solid solution, but the other containing 71.4 atomic % As showed 2 solid solution phases not in equilibrium. HFK (9b)

The Ternary Alloys of Cobalt-manganese-copper (Das Dreistoffsystem Kobalt-Mangan-Kupfer) W. KÖSTER & E. WAGNER. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 352-353. Experimental. The alloys of Co-Mn-Cu containing up to 40% Mn were examined by thermal and magnetic methods. The 2-phase field in the Co-Cu system is not closed in this composition range, so homogeneous ferromagnetic alloys do not occur. GD (9b)

The Magnetic Susceptibility of the Alloys of Zinc with Nickel, Cobalt and Iron (Die magnetische Susceptibilität der Systeme des Zinks mit Nickel, Kobalt und Eisen) J. SCHRAMM. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 327-334. Experimental. Magnetic susceptibility measurements were made on powder samples of various binary alloys with the following results: *Nickel-Zinc.* The reactions $\delta \rightleftarrows \Gamma + M$ (melt), 490° C.; $M \rightarrow \beta + \Gamma$, 875° C.; $\alpha + M \rightarrow \beta$, 1040° C.; $\beta_1 + \Gamma \rightleftarrows \beta$, 675° C.; $\beta_1 \rightleftarrows \alpha + \beta$, 810° C.; $\beta_1 \rightleftarrows \beta$ all gave sharp breaks in the temperature-susceptibility curves, but $\delta + \eta \rightleftarrows M$, 419° C., and $\Gamma_1 \rightleftarrows \Gamma + \beta_1$ (about 500° C.), Zn (melt) $\rightleftarrows$ Zn (solid) and $\Gamma \rightleftarrows \Gamma_1$ could not be detected. The following phase boundaries were established: $\delta - (\delta + \eta)$ at 10% Ni from 0° to 400° C.; $\Gamma - (\Gamma + \Gamma_1)$ and $\Gamma_1 - (\Gamma + \Gamma_1)$ at about 20% Ni; $\beta_1 - (\beta_1 + \Gamma_1)$ and $\beta_1 - (\beta_1 + \Gamma)$ at 45.5% Ni from 0° to 675° C.; $\beta_1 - (\alpha + \beta_1)$ at 52% Ni from 0° to 750° C.; $\beta - (\alpha + \beta)$ at 50% Ni above 850° C. The isotherms of the Γ alloys show a minimum between 15% and 17% Ni. *Cobalt-Zinc, (0-15% Co).* The reactions $\zeta \rightleftarrows \delta_1 + M$ 566° C.; $\delta_1 + M \rightleftarrows \delta$, 675° C.; $\delta_1 \rightleftarrows \delta + \Gamma$, 690° C.; $\delta \rightleftarrows \Gamma + M$, 746° C.; and $\delta_1 \rightleftarrows \delta$ were observed and the ζ phase has a minimum in the susceptibility values. *Iron-Zinc, (0-28% Fe).* All known three-phase reactions were observed and the following phase limits established: $\delta_1 - (\zeta + \delta_1)$ at 7% Fe from 0 to 530° C.; $\delta_1 - (\Gamma + \delta_1)$ at 11.5% Fe from 0 to 600° C.; and $\Gamma - (\alpha + \Gamma)$ at 28% Fe from 0 to 700° C. GD (9b)

Some Consequences of Degassing Metals at Ordinary Temperatures (Quelques Conséquences du Procédé de Dégazage des Métaux à la Température Ordinaire) GEORGES CHAUDRON, ALBERT PORTEVIN & LÉON MOREAU. *Comp. Rend.,* Vol. 207, July 18, 1938. pp. 235-237. Original research. The variation in the lattice parameter of the metals Pd and Ta was measured during degassing of the samples by ionic bombardment *in vacuo* at ordinary temperatures. This method is more effective in extracting H_2 than heating the sample in vacuo. Increases in the parameter, electrical resistivity and hardness due to the presence of H_2 are as follows:

Metal	Parameter a_0 (A.U.) Varies	Increase in Resistivity	Increase in Hardness
Pd (α)	3.882 to 4.020	69%	48%
Pd (β)	3.882 to 3.885	45%	266%
Ta	3.296 to 3.302	—	—

FHC (9b)

X-ray Studies on Cobalt-tungsten Alloys (Röntgenuntersuchung von Kobalt-Wolframlegierungen) A. MAGNELI & A. WESTGREN. *Z. anorg. allgem. Chem.,* Vol. 238, July 1, 1938, pp. 268-272. Experimental. The crystal structures of 2 phases in the Co-W system, Co_3W and Co_7W_6 were determined. Co_3W is hexagonal with $a_0 = 5.120$, $c = 4.120$ A.U. The atomic arrangement is the same as in Mg_3Cd, *i.e.* a superstructure of hexagonal close packed spheres. Co_7W_6 is rhombohedral with dimensions $a_0 = 8.92$ A.U., $\alpha = 30° 42'$; or $a_0 = 8.99$ A.U., $\alpha = 30° 40'$, depending on whether the phase is saturated with Co or W. The atomic arrangement of Co_7W_6 is the same as that of Fe_7W_6 and Fe_7Mo_6. HFK (9b)

Compounds of Titanium with Phosphorus. Contributions to the Systematic Affinity Theory No. 83 (Ueber die Verbindungsfahigkeit von Titan mit Phosphor. Beiträge zur systematischen Verwandschaftslehre. 83) W. BILTZ, A. RINK & F. WIECHMANN. *Z. anorg. allgem. Chem.,* Vol. 238, Aug. 2, 1938, pp. 395-405. Experimental. Contrary to earlier objections, it was found possible by 2 different methods to synthesize a monophosphide of Ti having the formula $TiP_{0.94}$, which is gray and metallic in appearance and has a characteristic X-ray pattern different from that of its analogue SiP. The compound is thermally stable even at 1000° C. X-ray patterns for preparations between Ti and TiP indicate the possible existence of a metallic appearing compound Ti_3P. HFK (9b)

The Cobalt Corner of the Iron-cobalt-vanadium System (Die Kobaltecke des Systems Eisen-Kobalt-Vanadin) W. KÖSTER & K. LANG. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 350-352. Experimental. Sections were studied that ran through the Co corner and contained ratios of Fe to V of 1:19, 1:4, 7:13, 1:1, 13:7, and 4:1. The solid solution of γ Co extends from 69 to 45% Co over this range. Curie temperatures and the $\gamma \rightleftarrows \epsilon$ transformations were determined, as well as the Brinell hardness of the alloys. GD (9b)

The Structure of Electrically Polished Copper Surfaces (Ueber die Struktur elektrisch polierter Kupferoberflächen) K. H. MOORE. *Ann. Physik,* Ser. 5, Vol. 33, Sept. 1938, pp. 133-137. The surface of an electrolytically polished Cu piece (as described by Lowery and Jaquet) was examined with electron diffraction and found to consist of little lamina of Cu_2O; these leaves or lamina are connected on dodecahedron planes. Only one orientation exists in which the edges of the cube of Cu_2O are parallel to the edges of the Cu cube. Ha (9b)

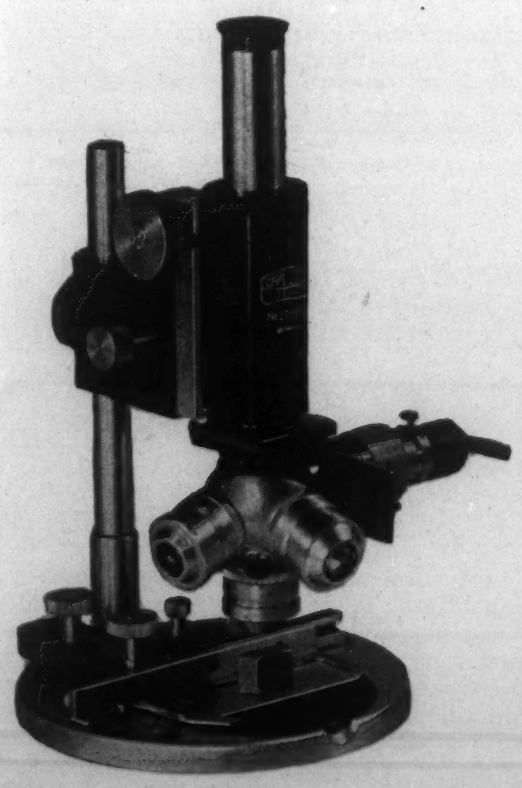
Some Ternary Systems of Aluminum (Ueber einige Dreistoffsysteme des Aluminiums) H. HANEMANN & A. SCHRADER. *Aluminium,* Vol. 20, Nov. 1938, pp. 771-774. Investigations were made of some ternary Al alloys, either to establish diagrams previously unknown or to correct inaccuracies in known ones. In the system Al-Fe-Mg, only the 3 crystal types Al (α), Al_3Fe and β (Al_3Mg_2) occur; no peritectic reaction was found. A ternary eutectic of α, β and Al_3Fe was found in many alloys consisting of 68% Al, 3% Fe, 29% Mg at 445° C., and a 2-phase alloy of Al_3Fe and β. The α-solid solutions have a tendency to crystal segregation. In the system Al-Mg-Mn, a ternary eutectic at 437° with 71.25% Al, 26.40% Mg and 2.35% Mn was established with the crystal types Al (α), Al_3Mg_2 (β) and Al_4Mn; the latter is easily recognizable by etching and by its behavior in polarized light. Although a peritectic reaction does not take place, a phase transformation Al_6Mn-Al_4Mn was observed, which is explained by the assumed existence of a metastable system with Al_4Mn and a stable system with Al_6Mn and Al_4Mn. Alloys with low Mg contents crystallize in the stable equilibrium, with high Mg contents in the metastable equilibrium. The system Al-Mn-Si has a ternary eutectic of 86.8% Al, 12% Si and 1.2% Mn at 575.5° C. with 3 ternary crystal types T, X and Y. T contains about 40% Mn and 15% Si and can absorb Mg and Si in solid solution. X is probably a ternary solid solution of the Al_3Mn phase. Homogeneous Y was found at 14-15% Si and 1-2% Mn. The 3 types are easily distinguishable by their etched sections and behavior in polarized light; X transforms peritectically into T and Al_6Mn. The diagrams of these 3 systems were constructed from these observations. Ha (9b)

X-ray Study of Heating an Al-Mg Solid Solution (Étude par Rayons X du Revenu de la Solution Solide Aluminium-Magnésium) PAUL LACOMBE & GEORGES CHAUDRON. *Compt. Rend.,* Vol. 207, Nov. 7, 1938, pp. 860-862. Original research. The authors show by X-ray studies the time of heating at 200° C. as a function of the change in parameter of a series of Al-Mg solid solution alloys containing 9, 11, 12 and 13.5% Mg, respectively. The alloys containing 12 and 13.5% Mg, on being heated 6 min. at 200° C., show an increase in lattice parameter from 4.1028 to 4.1064 A.U. for the former alloy, and from 4.1113 to 4.1158 A.U. for the latter alloy. Further heating causes the lattice parameter to decrease. The authors claim the increase in size is due to certain Mg atoms taking preferred positions on the lattice of the solid solution. FHC (9b)

Irregular Breaks of Dilatometric Curves in Cu-Al Alloys in the Region of 12% Al (Sur les Anomalies Dilatométriques Irrégulières dans les Alliages Cuivre-Aluminium à environ 12 pour 100 d'Aluminium) ANDRÉ BOUTILLIER. *Compt. Rend.,* Vol. 207, Sept. 19, 1938, pp. 498-500. Original research. A Cu-Al alloy with 12% Al was heated above 580° C. to form β solid solution. Cooled rapidly, the sample showed a break in the dilatometric curve corresponding to an increase in length beginning at 365° C. and ending at 300°-280° C., called transformation T_r. On being reheated to 450° C., a contraction took place at 400°-450° C., called transformation T_c. Again on being cooled, T_r occurred at 370°-280° C. Another 12% Al-Cu alloy, heated above 580° C. to form β, was then cooled slowly. At 365° C. (T_r), a contraction took place and thermal cycles up to 450° C. showed an elongation at 400° C. (T_c). Not only did the speed of formation of the constituents involved cause a change in contraction or expansion of the sample at T_r and T_c, but dimensions of the sample and slight variations of composition in the same sample were also effective. FHC (9b)

Effect of Cold Deformation on the Values of Crystal Lattice Constants. B. M. ROVINSKIY. *Zhur. eksp. i teor. fiz.,* Vol. 8, Jan. 1938, pp. 96-99. In Russian. Original research. Powdered samples of cold-rolled and of annealed Cu, mixed with annealed Al powder as calibrating substance, were investigated by the X-ray powder method, using Cu radiation in a camera of 114.6 mm. diameter. The X-ray spectrograms were photometered with a Zeiss recording microphotometer. A comparison of the intensity of the X-ray diffraction lines of the samples failed, within an error of 0.002 A.U., to disclose any change in the lattice constants of Cu due to cold deformation. The causes of the disagreement of this finding with that of Wood (see *Metals and Alloys,* Vol. 6, Jan. 1935, p. MA 26) are discussed. ORS (9b)

The Alloys of Cobalt with Boron, Arsenic, Zirconium, Columbium and Tantalum (Die Systeme des Kobalts mit Bor, Arsen, Zirkon, Niob und Tantal) W. KÖSTER & W. MULFINGER. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 348-350. Experimental. The Co-rich sections of the binary alloys of this metal with B, As, Zr, Cb and Ta were explored over a range that included the first eutectic in each system. The phases Co_2B, Co_4Zr, Co_5Cb_2 and Co_5Ta_2 were established, the first 2 being ferromagnetic. The diagrams include the Curie temperatures and the transformations in the terminal Co solid solutions. The Cb and Ta alloys showed appreciable aging when annealed at 800° C. GD (9b)



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10 · PROPERTIES AND APPLICATIONS

Including Relation of Properties to Engineering or Product Design. See also Sections 8a and 11.

M. GENSAMER, SECTION EDITOR

Cobalt and Its Alloys. Application in Mechanical and Electrical Industries (Le Cobalt et ses Alliages. Leurs Applications dans les Industries Méchaniques et Électriques) J. CHALLANSONNET. *Tech. Moderne,* Vol. 30, Aug. 1938, pp. 539-541. Comprehensive review. A French valve steel contains 0.95% C, 18% Cr, 2% Co, 1% Mo. Co is used in various magnet steels: KS type with 0.4-1% C, 36% Co, 1.5-3% Cr, 5-9% W (B_r = 9000; H_c = 270); Koester type with 17% W added to Fe_2Co and optional Mo content (B_r = 9600; H_c = 149); and Mishima type with 25-35% Co, 10-25% Ni, 8-25% Al or Ti, balance Fe (H_c = 1000 for Ti grade). Co-Ni alloys are used as regulators. Co-Cr alloys are the basis of Stellite. Co-Si compounds are resistant to halogens, but very difficult to make. Co-Be alloys (around 4% Be) are age hardening. The addition of Co to Cu retards softening on annealing. Cu-Be-Co alloys are used in electrical industry. See also *Metals and Alloys,* Vol. 10, Jan. 1939, p. MA 53L/5. JZB (10)

Non-ferrous Metals at the Motor Show. Increasing Use of Aluminum Alloys of all Forms. *Metal Ind., London,* Vol. 53, Oct. 21, 1938, pp. 387-388. Discussion of metallurgical developments as revealed at a British auto show. Brass as the main structural material for radiator shells is being superseded by Cr-plated steel and die-cast Zn-base alloys. The Al-alloy cylinder head and piston are now standard in a number of cars. Al alloys are also used in rocker covers, crankcases, sump, differential unit housing, steering box and the like. Zn-base alloy pressure castings are used for small components such as carburetor bodies, cover plates, etc. Both Alfa-Romeo and Lea-Francis exhibited models panelled with Al sheet. Normal practice is to use white metal bearings for passenger cars and Pb-bronze for heavy duty work. RWB (10)

Contributions of Metallurgy to Engineering Progress. W. R. BARCLAY. *Mech. Eng.,* Vol. 60, Aug. 1938, pp. 595-600; Sept. 1938, pp. 687-695. Excellent general summary and appraisal of the progress due to developments of new alloys, use of new metals and working processes for ferrous and non-ferrous metals. Topics discussed include: Alloy steels, high speed steels, corrosion- and heat-resisting steels, non-ferrous metals and alloys, Ni-Cu, Monel and related alloys, Ni-Cr and special Ni-containing alloys, Al and light alloys, Mg alloys, die-casting alloys, pure metals, powder metallurgy, Sn, Pb and Cu alloys and current research. Many tables of properties are included. 28 references. Ha + FPP (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

Liners Absorb the Wear. F. E. GOODING. *Steel,* Vol. 103, Sept. 12, 1938, pp. 40, 42, 70. Description of a Rex Pumpcrete for pumping concrete and of the ferrous metals used in its construction. Piston is cast Fe with 2% Ni, hardened to 335 Brinell, and ground to finished diameter. To resist abrasion, inlet and outlet valves and replaceable liners for pump cylinder and valve chamber are made of hardened S.A.E. 6145 steel, containing 0.40-0.50% C, 0.60-0.90% Mn, 0.80-1.10% Cr and 0.15-0.18% V. Liners are made by forming 2 flat plates to a semi-circular shape and welding together. These are hardened to full thickness by a single oil quench and draw, and then ground on outside to finished diameter. Curved parts of chamber are hard surfaced with No. 1 Stellite. MS (10a)

Magnetic Shields. W. B. ELLWOOD (Bell Labs.) *Bell Lab. Record,* Vol. 17, Nov. 1938, pp. 93-96. Review. Shields are used to protect electrical and magnetic equipment from stray magnetic fields. In a single shell, the shielding is proportional to permeability; in multiple shells, it is roughly a function of μ^n where n = number of shells. 3.8% Mo permalloy is best where a small field is to be shielded. For intermediate fields up to 5 gauss, perminvar is recommended; whereas for high fields, the 50:50 Fe:Co is most satisfactory. JZB (10a)

Aluminum as an Alloying Element in Steel (Aluminium als Legierungselement im Stahl) R. SCHERER. *Aluminium,* Vol. 20, Oct. 1938, pp. 682-687. Review. Al steels are divided into 3 groups: Pearlitic (with transformation), semiferritic and purely ferritic. Al represses the magnetic transformation and raises the Ac_1 transformation. Alloys with up to 5% Al can be worked cold, but alloys with 5-15% are very brittle and can only be worked hot, and then with difficulty. The most important fields of application now are nitriding steels, heat-resisting steels (or better, irons) and permanent magnet alloys. Nitriding steels provide high surface hardness with good depth of penetration, even with a low Al content; some types contain 0.20% Mo as well as the customary 1% Al. A nitriding steel containing 1.1% Al, 0.20% Mo and 1.8% Ni is employed for highly-stressed parts, as Ni gives a more uniformly nitrided steel. Al, in amounts from 0.6 to 5.0% is a very important constituent of several corrosion and heat resisting low-C Fe-Cr, Fe-Cr-Si and Fe-Cr-Co alloys. Alloys with 2-5% Al and more than 20% Cr resist oxidation at 1200°-1350° C. Increasing Al content increases heat-resistance but lowers acid-resistance. The most commonly used alloys for permanent magnets are given in the table:

Alloy	Composition: Co	Ni	Al	Ti	Remanence, B_r gauss	Coercive force, H_c oersteds	(BH) max. $\times 10^{-4}$
Ni-Al		16-18	9-12		7700-8800	170-140	570-630
Ni-Al		19-21	9-12		7500-8800	230-180	700-800
Ni-Al-Co .	2.4	19-21	9-12		7500-8800	300-250	900-1100
Ni-Al		24-30	12-15		6000-7000	575-475	1050-1300
Ni Al-Co .	4.8	24-28	12-15		5600-6600	725-600	1300-1450
Co-Ni-Ti-Al	32	16-17	4-5	9-10	5800-6300	800-750	1500-1700

These alloys are particularly valuable because of their magnetic stability up to 100° C. 16 references. Ha (10a)

Drift of Magnetic Permeability at Low Inductions after Demagnetization. G. R. PATTERSON (Carnegie Inst. Tech.) *J. Applied Phys.,* Vol. 9, Oct. 1938, pp. 646-653. Experimental. The observed drift in permeability of medium-Si steel at low flux densities is not due to errors in method but to the material itself. Permeabilities were carefully measured on an Epstein apparatus, meeting A. S. T. M. specifications, which is described in detail. After demagnetization from B = 10,000 gauss, permeability measurements at B = 10 g. showed a decrease of permeability with time in which 60% of the change in 24 hrs. took place in the first hr. This effect increased with the Si content, being greatest at 4.5% Si. On varying the test flux density, the greatest drift occurred at B = 5 g. and then gradually decreased to 25 g. For a steel of medium Si content tested at 10 gauss over 24 hrs., the decrease in permeability ranges from 5 to 15%. Possible explanations, including aging, are discussed. HFK (10a)

Cast Iron Research and the Gas Industry. J. G. PEARCE. *Inst. Gas Engrs. Communication* No. 183, June 1938, 26 pp.; *Foundry Trade J.,* Vol. 59, Sept. 15, 1938, pp. 199-201; Sept. 22, 1938, pp. 216-217. Review. The developments in cast Fe metallurgy and production of interest to the gas industry are reviewed. The uses of cast Fe in manufacture of gas and coke, in gas distribution and in gas utilization are surveyed. The properties of various grades of cast Fe, particularly in regard to mechanical strength and resistance to heat, corrosion, wear and erosion are surveyed. Cast-Fe alloys interest the gas engineer from 4 service aspects involving mechanical strength, heat resistance, corrosion resistance and wear or erosion-resistance. Mechanical strength, malleable cast Fe, gray Fe, fully-pearlitic irons, high-duty irons, heat-treated cast Fe, heat resistance, effects of thermal shock, corrosion resistance, wear-resistance, centrifugal castings, enamelling, etc., are discussed. AHE + AIK (10a)

Steel Construction at the New York World's Fair. JOHN PHILIP HOGAN. *Iron Age,* Vol. 142, Nov. 10, 1938, pp. 36-39. Practical description. General type of construction consists of steel frame and wooden studding covered with gypsum board. Over this is placed steel mesh. With the exception of the important structures, the steel is light, about 500 lb. to the piece. Stainless steel is also being used. Total estimated amount of steel and Fe to be used is 64,100 tons. VSP (10a)

Chromium Cast Irons. E. K. SMITH (Electro Metallurgical Co.) *Metal Progress,* Vol. 34, Nov. 1938, pp. 563-568. Descriptive. With more than 1% Cr (an element which causes the formation of carbides in cast irons and of more and finer pearlite), it is necessary in castings of thin sections to add a graphitizing element, such as Ni or Cu, to the melt. In a series of tests poured at constant temperature and varying amounts of from 0.04 to 2.18% Cr (the ferro-chrome added had the same C content as that of the gray cupola Fe) the combined C and transverse strength increased to a maximum at 0.50% Cr. The tensile and compressive strength increased throughout the entire range. Cr increases the impact resistance of cast Fe up to the point where carbides begin to appear in the microstructure (0.77% Cr in this case). This condition depends upon the section size, composition of the base metal, and the cooling conditions. With large section size and high Si and Mn, large amounts of Cr can be added without production of excessive hardness. The addition of 0.77% Cr raised the Brinell hardness to 207, but no difficulty was encountered in machining a bar containing 1.36% Cr that tested 241 Brinell. Cr irons have high wear resistance and are used for many articles subjected to severe abrasion. The analyses of 18 different Cr irons are given. The properties of Cr irons from 12% Cr to 34% Cr are also listed. At least 12% Cr is necessary in solid solution to confer corrosion resistance. If Si is present in excess of 2%, it interferes with the heat treatment and also slightly increases the as-cast hardness. The heat treatments of several Cr irons are mentioned. 6 references. CWH (10a)

The Effect of Alloying Additions on the Resistance of Steel to Hydrogen under High Pressure (Der Einfluss von Legierungszusätzen auf die Beständigkeit von Stahl gegen Wasserstoff unter Hohem Druck) F. K. NAUMANN. *Stahl u. Eisen,* Vol. 58, Nov. 3, 1938, pp. 1239-1250. Research. Alloying additions were made to a low-C steel and tensile tests made at room temperature after exposure to 300 atm. of H_2 for 100 hrs. at temperatures up to 600° C. After exposure at 400° C., the reduction of area began to fall rapidly, due to intergranular attack by the H_2. The elements that do not form carbides, such as Si, Ni and Cu, did not change the resistance to H_2 attack. Mn, which does not form a special carbide but goes into solution to some extent in Fe_3C, increased the resistance slightly. Cr, W and Mo gave a decided increase in resistance. These elements stabilize the carbides. When enough Cr was present to form the compound $(Cr, Fe)_7 C_3$, the resistance was further increased. Even these steels were slightly decarburized but with little effect in reducing the ductility. The effects of V, Ti, Zr and Cb were somewhat weaker than W and Mo, except when rather high amounts, up to 2-3%, were present, when they decidedly increased the resistance. This is attributed to the substitution of very stable special carbides for Fe_3C. For work on unalloyed steel, see *Metals and Alloys,* Vol. 9, Jan. 1938, p. MA 45 L/7. SE (10a)

Alloy Steels for Modern Still Tubes. R. L. WILSON (Climax Molybdenum Co.) *National Petroleum News,* Vol. 30, Mar. 23, 1938, pp. R-132, 134-138. Describes the comparative effect of the various useful alloying elements on the corrosion, oxidation, high temperature strength, and air-hardening of refinery tube steels. Many of the newer compositions are classified according to their serviceability, and the latest creep data are tabulated for some of the types. Small amount of Cr, as low as 2-2.5%, make extraordinary improvement in corrosion resistance. From that range to 6%, the rate of corrosion reduction is nearly linear. Si without Cr does not increase corrosion resistance, but is beneficial when accompanying Cr. Si reduces oxidation and scaling tendencies. Oxidation is retarded especially by the addition of Ti, W, Cb and Al; W especially is added for strength. Ti and Cb prevent air-hardening of Cr alloys. A list of 14 new alloys that offer good properties for specific purposes is included, along with their compositions and special properties; this is a very useful list to the refiner. 7 references. VVK (10a)

Thermal Conductivity of Iron and Steel. *Metallurgist (Suppl. Engineer),* Aug. 1938, pp. 152-154. Correlated abstract of 9 references. The recent work of Esser, Eilender and Pütz is checked against earlier investigations by others. The results of the German authors are higher than those of earlier workers, fully confirming the upward trend of recent determinations. The pronounced effect of the last few hundredths of a per cent of impurities on thermal conductivity is graphically shown by the steepness of the thermal conductivity-C content curves as they approach zero C. The austenitic steels had a distinctly lower thermal conductivity than the other classes examined and showed a slight increase in conductivity with rise in temperature; the latter, however, was less than that observed by others. Over the whole series of irons and plain-C and alloy steels, those with a conductivity more than 0.06 c.g.s. units showed a drop in conductivity towards that value as the temperature increased, while those with a lower conductivity showed a rise. The effect of the higher temperatures used in hardening and tempering still awaits investigation.

VVK + FPP (10a)

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Influence of Titanium and Molybdenum on the Magnetic Properties of Fe-Ni-Al Alloys. FESZCZENCKO-CZOPIWSKI & L. KOSLOWSKI. *Foundry Trade J.,* Vol. 59, Oct. 27, 1938, pp. 305-306. Original research. More than 210 sand-cast specimens were prepared. They were of the following dimensions: 18 x 18 x 103 mm.; 18 x 9 x 103 mm.; 18 x 6 x 103 mm.; 25 x 12 x 103 mm.; 25 x 6 x 103 mm. and 18 x 12 x 103 mm. The compositions of the castings were:

Castings	C	Si	Mn	S	P	Ni	Al	Ti	Mo	Cu
a	0.05	0.45	0.15	0.008	0.008	27.16	12.03	...	...	0.045
b	0.05	0.38	0.22	0.009	0.009	28.36	10.35	0.98	...	0.149
c	0.05	0.22	0.25	0.011	0.013	27.92	9.79	2.16	...	0.218
d	0.05	0.24	0.16	0.007	0.011	28.31	10.87	...	2.05	0.126

An apparatus of the Hartmann-Braun type was used in studying the magnetic properties. The following conclusions were drawn: (1) The coercive force H_c and the residual magnetism B_r of castings, a, b and d increased with the decrease of the section. The reverse phenomenon was observed with castings c. (2) The most effective heat-treatment for producing the maximum values of H_c and B_r in the castings a, b and c was oil quench from 1200°-1250° C., followed by 2-hr. tempering at 650° C. (3) The addition of 1-2% Ti increased H_c and B_r of Fe-Al-Ni alloy, provided that castings were subjected to the above-mentioned thermal treatment. (4) An addition of Mo had a deleterious effect on magnetic properties on specimens in "as-cast" condition. These alloys should be water quenched from 1200°-1250° C. and tempered for 1-2 hrs. at 650° C. AIK (10a)

A Magnetic Balance for Saturation Measurements. The Saturation Values of Cementite and C Steels as Function of Temperature and Previous Treatment (Eine magnetische Waage für Sättigungsmessungen. Die Sättigungswerte von Zementit und Kohlenstoffstählen in Abhängigkeit von Temperatur und Vorbehandlung) H. LANGE & K. MATHIEU. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 18, 1938, pp. 239-246. Description of the principle and construction of a magnetic balance that permits the determination of magnetic saturation as a function of temperature and the observation of transformation processes by measuring the force exerted on a sensitive balance by the sample in the electromagnet at different temperatures. An example of carburization of a piece of Fe by benzol vapors is described to show how the specific saturation of cementite can be exactly determined. The manner of calculation is explained. 10 references. Ha (10a)

Nickel in the Railroad Field. A. L. ROBERTS. *Southern & Southwestern Railway Club Proc.*, Vol. 26, July 1938, pp. 10-30. Descriptive survey. After a general survey of the use of Ni in steels, especially those employed in railroad operation, a recently developed alloy steel (Yoloy) of 0.06-0.25% C, 0.4-0.8% Mn, 0.04% max. P, 0.05% max. S, 1.75-2% Ni, 0.90-1.10% Cu, is described as particularly suitable for car construction. Low-C grade is employed where heavy forming or welding, or both, are to be done; medium-C, for less severe forming; and high C, where no forming is done. Tensile strength is 65,000-95,000 lbs./in.^{2}, yield point 70% of tensile strength, elongation in 8 in. 1,800,000/tensile strength. Impact value for low-C grade is above 50, for medium-C 40-50, for high-C under 35. The Mn content is 0.4-0.6% for 0.06-0.12% C, 0.5-0.7% for 0.12-0.17% C, and 0.6-0.8 for 0.17-0.25% C. A special field of application is in gasoline and oil tank trucks. Ha (10a)

The Development of High Strength Structural Steels (Die Entwicklung der hochfesten Stähle für den Grosstahlbau) P. HOFF. *Stahl u. Eisen*, Vol. 58, Sept. 29, 1938, pp. 1053-1057. Review. The German structural steels are classified according to tensile strength—St 37, of 37-45 kg./mm.^{2} (52,000-64,000 lbs./in.^{2}); St 48, of 45-58 kg./mm.^{2} (64,000-82,000 lbs./in.^{2}); St 52, of 52-62 kg./mm.^{2} (74,000-88,000 lbs./in.^{2}). Up to 1900, St 37, a 0.12% C steel, was used almost universally. As the demand arose for a stronger steel, a higher yield strength rather than a higher tensile strength was recognized as the main desideratum. However, after somewhat unsatisfactory experiences with expensive Ni and Ni-Cr steels, a plain C steel was used in 1924—St 52 with 0.30% C. Somewhat later Si additions were made. After experience with these steels, St 52 with 0.2% C, 0.5% Si, 1.2% Mn and 0.06-0.1% P was put on the market in 1928. This has high yield strength and, what is most important, is easily weldable. SE (10a)

Effects of Firing on the Steel of Cannon (Les Alterations de l'Acier des Canons Uses par le Tir) E. PIANTANIDA. *Mem. Artillerie Francaise*, Vol. 17, No. 1, 1938, pp. 137-152. Original research. Metallographic evidence shows that erosion of gun barrels is not caused by carburizing or nitriding of surface layers but by heat checking, as postulated by Tschernoff. No chemical alteration of the steel was noted. Surface layers were martensitic. Results compared favorably with author's work on guns of wartime manufacture. A cold-worked barrel (0.41 C, 0.31 Mn, 0.13 Si, 0.022 S, 0.022 P, 0.67 Cr, 2.12 Ni, 0.10 Mo, and 0.19 V) fired 494 rounds with initial velocities about 1000 meters per sec. A barrel not cold worked (0.31 C, 0.47 Mn, 0.17 Si, 0.007 S, 0.022 P, 0.61 Cr, and 2.57 Ni) fired 413 rounds at same initial velocities. Effect of cold working on erosion was not given. DJM (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

The Importance of Lanthanum as a Useful Material (Ueber die Bedeutung des Lanthans als Werkstoff) E. ARNDT & K. E. PÜTTER. *Angew. Chem.*, Vol. 51, July 9, 1938, pp. 463-464. Review. Lanthanum oxide is contained in fairly large percentages in monazite sands used for the manufacture of Th and incandescent gas mantles. La metal (atomic weight 138.9) has a specific gravity of 6.2 and a melting point of 810° C., tarnishes in air and behaves generally like Ca. La oxide and hydroxide are completely converted in air to La carbonate. Possible uses in ceramics are suggested. Some constitutional diagrams have been established of alloys of La with Pb, Sn, Tl, Ag, Cu and Au. La might also find some use as a catalyst. 14 references. Ha (10b)

Copper-chromium Alloys. M. G. CORSON. *Iron Age*, Vol. 142, Oct. 13, 1938, pp. 78, 80-81; Oct. 20, 1938, pp. 25-28. Original research. Gives historical data on Cu-Cr alloys and describes large experimental castings made for the study of the physical properties of the alloys, both in as-cast and heat-treated conditions. Discusses experimental results obtained. Detailed variations of physical characteristics throughout the castings are given in tabulated form. Shrinkage phenomena can be avoided by the addition of a small amount of Si to Cu-Cr. Cu-Cr castings in heat treated state have a proportional limit of at least 19,000 lb./in.^{2} and can be safely loaded to 17,000 lb. fiber stress. VSP (10b)

Microhardness of Bearing Alloys. L. L. SWIFT (Cleveland Graphite Bronze Co.) *Metals Tech.*, Vol. 5, Sept. 1938, T. P. 966, 12 pp. Original research. Hardness as determined by the microcharacter and methods of making such hardness tests are discussed. Microhardness values for most of the phases found in bearing materials are given. Micrographs of the scratches in several alloys are shown. Significance of the hardness of different constituents in a bearing metal is discussed. The relationship between hardness and wear is indefinite. JLG (10b)

Light Metal Bearing Surfaces (Leichtmetall-Gleitflächen) P. SOMMER. *Maschinenbau Betrieb*, Vol. 17, Nov. 1938, pp. 579-582. Interesting survey and research. The behavior of sliding surfaces from the metallurgical point of view depends on the quality of machining and the character of the material. The smoothness and accuracy of the surfaces are to a great extent independent of the internal properties of the material if proper machining procedure is used. Relationship between surface and structure of light metals are studied in the cast, die cast, diamond cut and polished condition. Pistons are machined in a direction normal to that of sliding-in operation, this is why rubbing-off occurs during running-in period. Heat treated Al-Si and Al-Cu alloys (as used for pistons) do not possess good emergency running properties in case of critically poor lubrication. Anodic oxidation helps, as this coat improves adhesion of the oil film; it does not, however, induce better wear or lower the friction. Another method is to cover the surface with a very thin layer of soft metal (Babbit), which is squeezed out at highly stressed zones thereby better distributing the stress. The soft metal layer imparts to the new Al surface the ability to attain the desired surface quality quicker than by rubbing-off. The influence of structure on the bearing properties often depends on how the structure is affected by running-in, and particularly on the presence of crystals that differ in hardness from the matrix. The graphite flakes of cast Fe spread out and protect the metal. At low loads with good lubrication the Al alloy surface is smooth but dull. When load increases, the surface becomes shiny, the oil adhesion becomes worse. At still higher loads the surface turns dark, finally black. In this condition higher friction and tendency for "seizing" exist. There seems to be a relation between metal structure and tendency to galling. Materials with heterogeneous, fine and uniform structure are better; local overstress is less harmful. Materials with essentially tough and strong matrix and low percentage of hard "bearing" crystals seize more easily. Also, alloys which contain a great many hard and brittle crystals are subject to seizing; in this case no welding but splintering and jamming of hard particles occurs. A running surface that once seized will not give good service even if it appears intact. In order to clarify the problem of sliding friction, running-in tests were made. Some metals never assume a definite "run-in" condition. The friction of run-in surfaces may change during operation, when the pressure is varied. Some heterogeneous structures seem to show elastic effects so that the carrying and non-carrying constituents move against each other after relieving stress so as to assume a new equilibrium. Some alloys, upon reaching a critical temperature range, change their equilibrium of solution or recrystallization, which effect may reflect upon surface condition and friction. The wear resistance of cylinder cast iron is better than Al-Si (16-27% Si); then come Al-Si (11-14% Si), Al-Cu and Mg. Wear resistance of light alloys is nearly the same in soft and hardened state. Therefore, that part of the structure that is not changed by heat treatment seems to be the controlling factor. RPS (10b)

The Mechanical Properties of Various Copper Alloys at Room Temperature (Sur les Propriétés Mécaniques de quelques Alliages du Cuivre à la température Ordinaire) W. BRONIEWSKI. *Rev. Mét.*, Vol. 35, Aug. 1938, pp. 333-349; Sept. 1938, pp. 385-397. Review plus original research. To compare published elongation values obtained on various size specimens, it is necessary to separate the % elongation into uniform elongation and non-uniform elongation due to contraction at the point of fracture, and to calculate the "work to rupture" according to a formula, given in the text. A compilation of published data on the phase diagrams and mechanical properties, including work to rupture of the alloys of Cu with O, S, Ni, Mn, Zn, Sn, Ag, Au and Al (86-100 wt. % Al), is given, including the effect of heat treatment on the Sn, Ag, Au and Al alloys, and the effect of cold work on the Zn, Sn and Ag alloys. New data are presented for the Cu-Si alloys (up to 6 wt. % Si), and for the Cu-Al alloys (up to 13 wt. % Al). Finally, the age hardening of Al by Al_2Cu, Mg_2Si and Si was studied. The Si is just as effective as the Al_2Cu but less than the Mg_2Si, which, however, should not exceed 1.5% for the best mechanical properties. JZB (10b)

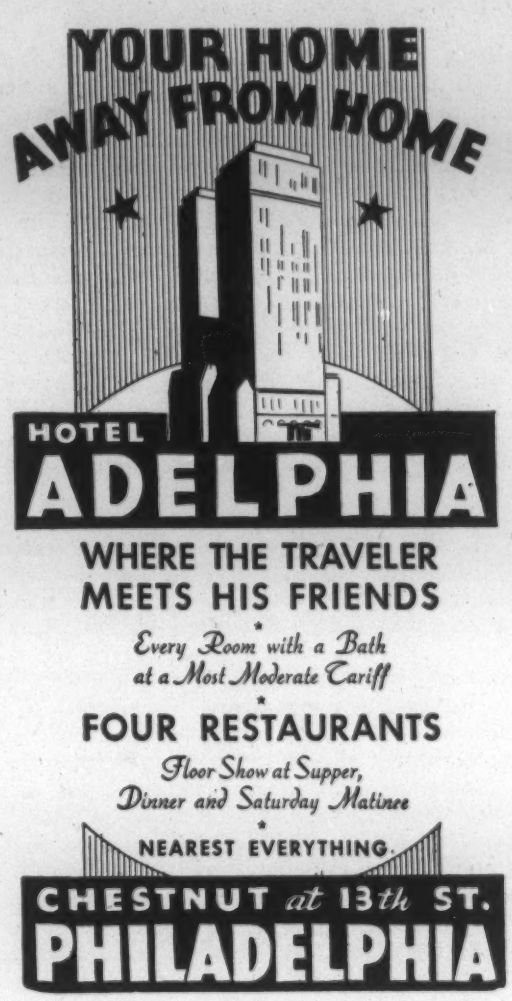
Effect of Cold-working and Heat-treatment on the Electric and Magnetic Properties of Pure Nickel (Einfluss von Kaltbearbeitung und Wärmebehandlung auf die elektrischen und magnetischen Eigenschaften von reinem Nickel) H. BITTEL. *Ann. Physik*, Ser. 5, Vol. 32, Aug. 1938, pp. 608-624. Original research. Wires of carbonyl Ni showed an increase in electrical resistance under elastic twisting. If the wire is twisted in a magnetic field the increase is very small; Ni thus behaves exactly like other non-ferrous metals in this respect. Plastic torsion does not cause magnetic anisotropy, and the resistance is changed but little. The wires "recover" from the effects of cold-working at the same annealing temperature; the recovery temperature decreases with increasing degree of deformation. The change in electric resistance is explained as due to certain magnetic phenomena. 16 references. See also *Metals and Alloys*, Vol. 9, July 1938, p. MA 444 L/9. Ha (10b)

A Further Report on Physical Properties and Clinical Value of Platinum-centered Gold Foil as Compared to Pure Gold Filling Materials. R. W. RULE. *J. Am. Dental. Assn.*, Vol. 24, Apr. 1937, pp. 583-603. Original research. Specimens, 10 x 1.5 x 1.5 mm., were prepared in steel dies using "condensers" of different sizes (0.36 and 1 mm.^{2}) and different applied pressures. These specimens were machined in the gage length for the tension tests. Of the 43 specimens prepared, 23 were pure Au and 20 Pt-centered Au foil with Pt ranging from 10 to 40%. Brinell hardness, density, tensile strength and elongation were determined. The average hardness of the pure Au specimens was 54 Brinell, with the range being 38 to 73. The 10 and 15% Pt alloy specimens showed one reading of 62 and 10 ranging from 70 to 78. The 9 specimens of 30 and 40% Pt ranged 88 to 110 Brinell. The average of the high-Pt specimens was 42 points above the pure Au. The densities of the pure golds ranged from 18.0 to 19.5 with an average of 19.1, while the average for the 10 and 15% Pt alloys was 19.5 and for the 30 and 40% Pt, 19.8. The tensile strength was greatly influenced by the size of the condenser (packing pressure), the averages being 38,500 and 28,800 lbs./in.^{2} for the small and large, respectively, for pure Au. For specimens made with the small condenser, the average tensile strengths were 38,500, 47,500 and 50,000 lbs./in.^{2} for pure Au, 10-15% Pt and 30-40% Pt, respectively. The elongations averaged 12.8, 5.5 and 3.9% for the pure Au, low-Pt and high-Pt specimens, respectively. Crystal Au condensed less readily and gave lower values than Au foil, while electrolytic Au gave about equal values. One crystal Au was condensed with a fluid, as recommended by the manufacturer, but showed practically no cohesion. The Pt-centered foil can be used to develop higher hardness, better wear resistance and higher strength than can be obtained with pure Au foil. Some care in annealing the Pt-centered foil is recommended to avoid "burning off" the Au and thus decreasing cohesion. **Gold Foil and Platinum-centered Gold Foil; Methods of Condensation.** *Ibid.*, Nov. 1937, pp. 1783-1791. Comparisons were made with pure Au foil and 16 and 30% Pt-centered foils, using pellets of ¼ and ½ grain sizes and 5 methods of condensing. Specimens were prepared in steel dies and in "ivorine." The smaller pellets produced specimens of higher hardness and of greater strength. The thinner golds were easier to condense and generally gave specimens of higher hardness and greater strength. Specimens prepared in "ivorine" showed lower hardness and lower strengths than specimens prepared in steel dies. The maximum hardness for pure Au was 65 Brinell, and for 30% Pt 98. The maximum tensile strengths were 45,000 and 61,000 lbs./in.^{2} for pure Au and for 30% Pt, respectively. Using heavier foil for the Pt-centered material seemed to eliminate "burning off" of the Au in annealing. OEH (10b)

Properties and Microscopic Structure of Gold and Gold-platinum Foils. JOHN S. SHELL. *J. Am. Dental Assoc.*, Vol. 24, Nov. 1937, pp. 596-603. Original research. Compare with preceding abstract. Specimens (10 x 1.5 x 1.5 mm.) were prepared in steel dies and hardness, tensile strength and microstructures determined. The specimens were turned to 1.25 mm. diameter and 7 mm. gage for tension tests. The average hardness of pure Au was 54 Brinell, which falls in the range (40-75) for soft casting golds. The 10-15% Pt foils averaged 78 Brinell, which is within the range (70-100) for medium hard casting golds. The average for the 30-40% Pt specimens was 96, which is within the range (90-140) for hard casting golds. The average tensile strengths were 36,000, 45,000 and 40,000 lbs./in.^{2} for pure Au, 10 and 15% Pt, and 30 and 40% Pt, respectively. One specimen, 45% Pt, showed a tensile strength of 59,000 lbs./in.^{2} The density ranged from 98.2 to 99.9% of the theoretical or calculated density. The highest density was for a 10% Pt. specimen. The microstructure showed some slight lack of complete homogeneity in all specimens and the Pt-alloys showed some areas of Pt color. "Crystal" Au condensed to as homogeneous structures as the other materials but showed lack of cohesion, and it was impossible to prepare specimens for tension tests. The value of higher strengths in the Pt-alloy foils is evident for some applications. OEH (10b)

Contact Problems in the Use of Pure Magnesium as Bus Bar Material (Kontaktfragen bei der Verwendung von Reinmagnesium als Stromschienenwerkstoff) W. BULIAN. *Elektrotech. Z.*, Vol. 59, Aug. 18, 1938, pp. 879-881. Descriptive. The low specific gravity (1.74) of Mg permits lighter structures than for Cu or even Al bus bar systems, and the greater strength of Mg is another advantage over Al. Experiments have shown that bolted connections give better and longer durable contacts than Al joints, a contact pressure of 7,000 lbs./in.^{2} being sufficient. Ha (10b)

Tin-coated Light Metal Pistons (Leichtmetall-Kolben mit verzinnter Lauffläche) W. MUNDORFF. *Deut. Motor Z.*, Vol. 15, Feb. 1, 1938, p. 4. Original. 3 pistons of different surface finish were broken in at —110° C. by 20 starts of 1 min. duration. The untreated piston exhibits many surface defects. One piston, treated by the Eloxal method, showed slight wear. The Sn-coated piston was free from any defects of the surface. EF (10b)



The Mechanical Properties of Aluminum-magnesium Alloys. BRONIEWSKI, BERNACIAK & BLAZEWSKI. *Aluminum & Non-Ferrous Rev.*, Vol. 3, Oct. 1938, pp. 365-368. Original research. Primary alloys of Al (impurities of 0.4%) with Mg (impurities of about 0.3%) were investigated. An electric resistance furnace was used for fusion. Heat treatment used was: Annealed for 3 hrs. at 450° C., furnace-cooled to 100° C. (12 days), air cooled; quenched from 450° C. (after 5 hrs. at temp.) in water of 20° C.; tempered at 200° C. (3 hrs.), then quenched in water. For Al-base alloys, the effect of heat treatment becomes evident with 5% Mg. Quenching gives maximum elongation and contraction; tempering results in maximum strength and elastic limit. At 8% Mg, the deformation reaches a minimum; from there on it increases with higher Mg content. For Mg-base alloys, tensile strength and elastic limit increase with Al content. The hardness curve of Al-base alloys is similar to the strength curve. The impact value drops rapidly with increasing Mg content for the annealed alloys; this drop is less marked for hardened alloys, as the impact value stays above 4 kg.-m./cm.^{2} up to 9% Mg. For Mg-base alloys, the hardness increases with Al. Impact is low with 1 kg.-m/cm.^{2} at 5% Al. Outstanding compositions of the 2 types are: (1) 91% Al, 9% Mg, water quenched; (2) 94% Mg, 6% Al. RPS (10b)

The Influence of Beryllium on Brass Alloys (Ueber den Einfluss von Beryllium auf Messing-Legierungen) W. HOCK, FINOW & P. RÖNTGEN. *Metallwirtschaft*, Vol. 17, **Part I. Microstructure,** Sept. 23, 1938, pp. 997-1003; **Part II. Age Hardening and Mechanical Properties,** Sept. 30, 1938, pp. 1022-1028. Original research. Study of the effects of additions of 0.1, 0.2, 0.5 and 1% Be on the microstructure and age hardening properties of several brasses containing 72, 67, 64, 60 or 57% Cu. The addition of Be causes grain refinement, and the $\alpha/\alpha + \beta$ and $\alpha + \beta/\beta$ phase boundaries of the Cu-Zn system are shifted toward higher Cu concentrations. In this respect Be is more powerful than Al. The tensile strength and hardness of the various brasses is increased by the addition of Be, the additions of which are more effective in alloys with an α matrix than in those with a β matrix. The precipitation hardening effect is greatest in an alloy with 72% Cu. Corrosion tests in 3% NH_3, 3% H_2SO_4, 3% HCl and 3% NaCl showed no detrimental effect of Be on the corrosion resistance of these alloys, in several cases apparently increasing the corrosion resistance. GA (10b)

Copper Alloys in Engineering. Their Adaption to Modern Requirements. H. J. MILLER. *Metal Ind., London,* Vol. 53, Nov. 11, 1938, pp. 461-464; Nov. 18, 1938, pp. 493-496; Nov. 25, 1938, pp. 521-524. Review. Modern Cu alloys are classed as: Materials for service at elevated temperatures, high strength constructional alloys, alloys for bearing service and free machining materials. High purity Cu may be completely annealed at less than 200° C.; therefore, special alloys are employed when high temperatures are involved. Tough pitch Cu, because of its cuprous oxide content, deteriorates by "gassing" when heated in reducing atmospheres. For this reason, considerable use is made of P-deoxidized Cu, which contains about 0.015-0.05 P. The P has little influence on the mechanical properties, but the electrical conductivity is reduced to about 70%. Several other elements have been used as deoxidizers; where high electrical conductivity is required, O-free Cu made by other methods is available. O-free and deoxidized Cu are not only easy to weld but are often superior in service. Cu alloys containing Al, Mg or Be, which form protective films, are used where resistance to oxidation at elevated temperatures is necessary. Alloys of 5-11% Al are outstandingly useful in this respect. Resistance to oxidation may be enhanced by selective oxidation. Absolute resistance to oxidation is seldom necessary and it is often satisfactory to use only slightly modified varieties of Cu. Elevated temperature service requiring retention of mechanical properties may be divided into 2 classes: That in which work hardness must be retained, and that in which the metal is used in the annealed state. Retention of cold work at slightly elevated temperatures is found in Cu-Ag; Ag or Cd raises the annealing temperature without excessively depressing conductivity. 1% Cd-Cu can be used at temperatures up to 200° C. With precipitation-hardening alloys used for welding electrodes, continued exposure to temperatures almost up to the precipitation range will not result in softening, even in very long periods of time. The maximum service temperature of Cu-Cr alloys is placed at 350° C. Cu-Ni-Si alloys (97.5 Cu, 2 Ni, 0.5% Si), which precipitate Ni_2Si, possess good hardening characteristics, but may be too brittle for service requirements. To overcome this, modified alloys, such as 98.75 Cu, 0.75 Ni and 0.5% Si, have been developed. Cu-Co-Be and Cu-Ni-Al alloys are also serviceable at elevated temperatures. An important feature of the Cu-Co-Be alloy is that it has an electrical conductivity of over 50% and can be used at 400° C. For turbine blading, P-bronze is still used to some extent for the low-pressure stage, but in the high-pressure stage Cu-base alloys have been displaced by Monel. The high temperature properties of Cu-Ni improve as the Ni is increased to about 70%. Cu-Mn (5 Mn) alloy is favored for locomotive stayrods. Cu-Al alloys are good up to 400° C. Correlation of creep performance with certain other properties has been attempted and it is apparent that materials with high recrystallization temperatures are desirable. Temper hardening alloys with a high optimum heat treatment temperature, such as Cu-Cr, Cu-Co-Be, Cu-Bi-Al and Cu-Ni-Si series, all of which are heat treated in the range 450°-550° C., are better than those alloys with a low heat treatment temperature, as typified by the Cu-Ni-Sn and Cu-Be series, which harden at about 300° C. Cu alloys now available for room-temperature service are numerous in comparison with those of a few years ago. Maximum electrical conductivity coupled with strength is found in 0.5-1% Cd alloys. Wire of this alloy has 50% greater strength than hard drawn Cu with an electrical conductivity of about 83-95%. When conductivity is unimportant, increased tensile properties may be obtained by additions of Sn, Si and Al. Cu-Fe-P alloys (2 Fe, 0.5% P) may be heat treated to give high conductivity values (90%). Cu-Cr alloys are of most importance in the cast condition. Wrought Cu-Cr alloys lack the strength of Cu-Cd. Co and Be additions give tensile strengths up to 50 tons/in.^{2} with an electrical conductivity of about 50%. In the development of new casting alloys, relatively little progress has been made in recent years. Ni additions to gunmetal give better mechanical properties. The favored alloy is 88 Cu, 5 Sn, 5 Ni and 2% Zn. Cu-Be of 2.25-2.5 Be responds to heat treatment and develops high tensile strength. In tonnage, the largest single use of Be-Cu is for minimum-sparking tools. Until recently, fabrication of Cu-Sn alloys was confined to the α range, with 9% as the limiting Sn content for cold work. With the new low-gas technique in casting, it is possible to fabricate alloys of 14% Sn. Low temperature heat treatments not only reduce the tendency to season-crack, but improve the proportional limit and proof stress of cold-worked materials. The Cu alloys used for corrosive services include brasses, Si-bronze, Al-bronze and alloys with Ni. Cu alloys for bearings have been conventionally based on cast Cu-Sn and Cu-Sn-P alloys. Recent developments include wrought, molded and Cu-Pb bearings. Wrought bronzes are usually 8-10% Sn. Additions of either Cr or V with Fe results in a duplex system of α-solid and alloy-rich intermetallic compound. Porous bearings are made by feeding Cu and Sn powder with graphite into molds in self-ejecting presses; the formed products are afterwards sintered in reducing atmospheres. Typical Pb or "plastic" bearing bronzes are 78/7/15 or 70/5/25 Cu/Sn/Pb. Modern Cu-Pb bearings for high duty service were evolved from these. Production technique varies, but invariably the Cu-Pb is applied as a very thin layer on a steel shell. Free machining materials are also discussed. 37 references. RWB (10b)

New Nickel Alloy. *Heat Treating Forging,* Vol. 24, Oct. 1938, p. 507. Describes properties of "Z-Nickel," which contains 98% Ni and can be heat treated to give high strength values while retaining corrosion resistance of Ni. It has a density of 8.75; specific gravity of 0.316 lb./in.^{2}; electrical resistivity of 84-96 ohms/mil-ft. at 20° C., temperature coefficient being 0.0036/1° C.; tensile modulus of elasticity of 30,000,000; and torsional modulus of elasticity of 11,000,000. Strength is 2.5-4 times that of ordinary structural C steel. It has been produced with tensile strength of 250,000 lbs./in.^{2} and hardness of 46 Rockwell C. In the unhardened or annealed state, it fabricates almost as easily as pure Ni. It can be heat treated after fabrication with little distortion, since heat treating is done at 890°-930° F. for 6-16 hrs. Hardening in an H_2 atmosphere, which need not be dried, prevents slight discoloration. Quenching from 2000° F. is required to render the alloy susceptible to heat treatment. It is produced commercially as hot-rolled or cold-drawn rods, wire and cold-rolled strip, furnished unhardened or heat treated. Unhardened cold-rolled strip is produced in soft, half-hard, or full-hard tempers with minimum tensile strengths of 90,000 lbs./in.^{2}, 130,000 lbs./in.^{2} and 155,000 lbs./in.^{2}, respectively. Heat treatment increases these by 30,000-70,000 lbs./in.^{2} The range of mechanical properties is tabulated. MS (10b)

The Development of High-strength Electrical Conductors and Messenger Cables. C. H. DAVIS & I. T. HOOK (Am. Brass Co.) *Wire & Wire Prod.,* Vol. 13, Nov. 1938, pp. 665-670, 692. Exhaustive survey and complete description of experiments and experiences leading to the present perfection of messenger cables that have a tensile strength of 73,000 lbs./in.^{2} with 2.75% elongation in 10 in. for wire 0.365 in. diameter. Cu alone does not develop more than 66,000 lbs./in.^{2}; Cu alloyed with Sn only is unsatisfactory for messenger cable strand, as difficulties in hot-rolling and cold-drawing occur with 3% Sn. Al-Cu and Si-Cu alloys give better strength but a greatly reduced electrical conductivity. Sn bronze, deoxidized and hardened with 3% Si, is difficult to hot-roll and cold-draw, and is unsuitable for messenger strands. Sn bronze deoxidized with either Al or 2% Si gives satisfactory strength, but low conductivity. Increasing amounts of Al added to Cu increase suitability. 5% Al and 95% Cu is an exceptionally good hot forging bronze. Tables showing mechanical properties of different bronzes are given. The properties of "Calsun" bronze (Cu-Al-Sn, U. S. Patent 1,630,999), which is corrosion-resisting and has 17% conductivity, are discussed. Ha (10b)

Studies on Gallium, Indium and Thallium (Studien über das Gallium, Indium und Thallium) E. EINECKE. *Z. anorg. allgem. Chem.,* Vol. 238, July 1, 1938, pp. 113-174. Experimental. Many of the properties of Ga, In and Tl were studied, some for the first time. The hardness, ductility and tensile strength of Ga single crystals were determined. In contrast to the exceptionally plastic metals In and Tl, Ga is brittle and unyielding almost up to its melting point. Unlike In and Th, Ga could be welded by methods excluding O. The laws of solidification speed observed in non-metals should, according to the observations made on Ga, be valid for metals also. The constancy of linear and cubic crystallization per unit time at a definite temperature was established and the dependence of the freezing on the cross-section and super-cooling was studied. Ga is mechanically dispersable into only coarse emulsions, but its colloid synthesis is possible by electrochemical means that are described. The anodic behavior of Ga in alkali, acid and neutral electrolytes was studied, together with its polarizability. The electrolytic valve action of Ga was studied in both solid and liquid states. The potentials and degree of rectification (in part comparable to those of Al) were determined. All properties of Ga studied were compared in detail with the corresponding properties of its neighboring metals in the periodic system especially In and Tl. HFK (10b)

The Latent Heat of Fusion of Aluminium. J. H. AWBERY. *Phil. Mag.,* Vol. 26, Nov. 1938, Suppl., pp. 776-784. Research. A review of published values shows 2 different groups, one with a mean value of about 92 cal./g., the other 77 cal./g. A new electrical melting method was used and 92.4 ± 0.5 cal./g. was established as the most probable value. The low values in literature are attributed to impurities in the samples or inaccuracies of methods used for the determination. 8 references. Ha (10b)

The Effect of Small Lead Additions on Silumin (Ueber den Einfluss geringer Bleizusätze auf Silumin) H. BAUER & H. WINTERHAGER. *Aluminium,* Vol. 20, Oct. 1938, pp. 700-704. Original research. Small additions of Pb (in the form of lead chloride) to eutectic Al-Si casting alloys were investigated. No improvement on the mechanical strength could be observed. In alloys with 0.5% Mg and Pb from 0.07 to 0.5% the Pb comes to the surface after annealing at 525° C.; this does not occur in alloys with 1% Mg and 0.1% Pb. Ha (10b)

Influence of Elements on the Properties of Lead. Part VII. The Influence of Composition on the Creep Rate of Industrial Lead. J. NEILL GREENWOOD & HOWARD K. WORNER. *Proc. Australasian Inst. Mining Met.* No. 104, Dec. 31, 1936, pp. 385-422. Original research. For Part VI, see *Metals and Alloys,* Vol. 8, Oct. 1937, p. MA 629 L/1. Ag in the cast alloy occurs partly as free particles and partly as solid solution. By suitable treatment, up to 0.1% Ag can be taken into solid solution. This amount of Ag increases hardness and resistance to creep. Ag decreases grain size after rolling. The creep rate (50-100 days) of alloys containing 0.01-0.05% Ag is of the order 3 x 10^{-5} in./in./day under a stress of 350 lbs./sq. in. in the basically annealed condition. Ag-Pb is not appreciably different from ordinary Pb in retaining cold work hardness at room temperature, but this may not be true if Ag is in solid solution. Sb in amounts used is in solid solution. It has little influence on hardness or rate of creep at 350 lbs./in.^{2} The creep rate (50-100 days) under this stress for alloys containing up to 0.1% Sb is of the order of 9 x 10^{-6} in./in./day in the basically annealed condition, about 3 times the rate for Ag alloys. Under 500 lbs./in.^{2} stress, creep rates of these alloys are greater than for Port Pirie Pb; Russell reported a decrease in rate with 0.05% Sb in electrolytic Pb, indicating the marked influence of traces of elements. An alloy containing 0.01% Sb was exceedingly sensitive to grain growth on annealing. With 0.1% Sb, the alloys gave a more regular and greater elongation than Port Pirie Pb and finally broke in an intercrystalline manner. Bi shows appreciable solid solubility in Pb. It has little influence on hardness. A slight increase in Bi caused a marked initial increase in rate of creep, but as Bi was further increased, this effect became less and less. In the basically annealed condition, this anomaly disappeared and Bi had little influence. Creep rate (50-100 days) of Pb alloys containing up to 0.1% Bi under 350 lbs./in.^{2} stress is of the order of 7x 10^{-5} in./in./day. Bi has little effect on grain size after rolling, but the alloy containing 0.005% Bi was very sensitive to grain growth on annealing. Zn shows slight solid solubility in Pb, about 0.1%, this solution forming a eutectic with any excess Zn over this amount. Zn decreases creep rate slightly, but the effect is neither so marked nor so regular as that of Ag. **Part VIII. The Influence of Copper.** J. NEILL GREENWOOD & C. W. ORR. *Ibid.,* No. 109, Mar. 31, 1938, pp. 1-24. Cu is only slightly soluble in Pb, and even 0.007% can be detected microscopically in cast and rolled alloys. Up to 0.06% Cu is dispersed in fine particles as a eutectic; above this, Cu crystals appear with a tendency to mechanical segregation. Cu does not greatly affect the hardness of Pb, either annealed or rolled. Up to 0.01% Cu increases creep rate; further additions up to 0.06% cause a rapid fall in creep rate, and after this there is substantially no further effect. Cu increases the stability of the crystal lattice of Pb, enabling the latter to withstand greater deformation without recrystallization. Vibration superposed on direct stress appreciably increases creep rate. Pb containing 0.07% Cu has a creep rate under 350 lbs./in.^{2} stress and with vibration about 0.1 that of Point Pirie Pb. Pb containing 0.06% or more of Cu, even with vibration under 350 lbs./in.^{2} stress, stretches less than 1% in the first year and develops a creep rate of less than 0.5%/annum; Point Pirie Pb gives this result with stress less than 200 lbs./in.^{2}. AHE (10b)

10c. Effect of Temperature

H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation of the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necesharily subscribed to the statements of either the author or the abstractor.

Investigation of the Suitability of High Temperature Materials for Combustion Engines (Untersuchung über die Eignung Warmfester Werkstoffe für Verbrennungskraftmaschinen) F. BOLLENRATH, H. CORNELIUS & W. BUNGARDT. *Metallwirtschaft,* Vol. 17, July 15, 1938, pp. 755-757. Research. Investigation was made of 24 alloys consisting of austenitic steels and low-Fe heat resistant alloys with regard to their use for an exhaust turbine operating at high temp. The stress necessary to produce a 1% elongation in 300 hrs. at 600° C. was taken as a criterion for the suitability of these materials for turbine blades. From data on the 24 materials tested it was determined that Ti additions in small amounts (1-3%) increase the high temp. creep strength most. Of the various elements studied, Ta and Cb are next in order as regards increase of high temp. strength of steels to which they are added. [In the austenitic steels, the effect of significant differences in Cr and Ni content have been neglected and the beneficial effects of Ti, and Ta and Cb are not proved.—H.C.C.] GA (10c)

The Creep Strength of Fusion-weld Electrode Materials (Untersuchungen über die Dauerstandfestigkeit von niedergeschweissten Elektrodenwerkstoffen) H. M. SCHNADT. *Arcos Z.,* Vol. 15, Aug. 1938, pp. 1851-1860. Original research. 2 types of electrodes were studied: (1) 0.14 C, 0.51 Mn, 0.05 Si, 0.02 S, 0.02% P; and (2) 0.10 C, 0.92 Mn, 0.03 Si, 0.02 S, 0.02% P. Temperatures of 450° and 500° C. were employed with the following results:

Electrode No.	Temp., °C.	Stress (lbs./in.^{2}) to produce creep rates between 25th and 35th hrs. of 1.5×10^{-3}%/hr.	1.0×10^{-3}%/hr.	0.5×10^{-3}%/hr.
1	450	19,500	18,500	16,300
2	450	21,300	20,000	17,100
2	500	13,100	12,100	9,400

It was also shown that (a) at 450° C. the creep strength of each electrode material is at least equal to that of rolled or forged steels of similar composition and heat treatment; (b) between 450° and 500° C. the drop in creep strength of electrode (2) was very similar to that of simultaneously tested comparison steels; and (c) at 500° C. the creep strength of electrode (2) is at least equal to that of corresponding rolled steels. [It should be remembered that what the author calls creep rates are more of the nature of proportional limit tests and bear no sure relation to long time creep.—H. W. G.] GN (10c)

Determination of the Creep Limit by Various Methods (Bestimmung der Dauerstandfestigkeit nach verschiedenen Verfahren) A. KRISCH. *Arch. Eisenhüttenw.,* Vol. 12, Oct. 1938, pp. 199-206. Original research. The creep limit at 500° C. of a 0.12% C, 0.33% Mo and 0.20% Cu steel and of a 0.15% C, 0.80% Cr, 0.53% Mo and 0.13% Cu steel was determined by 12 different methods, including those used in Germany, by the National Physical Laboratory and others in England, and by laboratories in the United States. In general, the different accelerated tests and those tests in which the creep limits were for total extensions as large as 1% in 10,000 hrs., gave fairly consistent values, the deviations being within ± 2,800 lbs./in.^{2} Tests such as the determination of the creep limit at a stress giving a creep rate of 5 x 10^{-4}% per hr. during the 25th to 35th hrs. (German method); the determination of the load giving a total extension of 0.1% in 10,000 hrs. (American method); and the determination of the load giving a creep rate in the 24th to 72nd hr. of less than 1 x 10^{-4}% per hr. (Hatfield's "Time Yield" method) gave lower values. Impact tests and microscopic examinations after 1,000 hrs. loading showed no changes in the steels. SE (10c)

The High Temperature Properties of Magnesium Alloys (Elektron) under Static Tensile Stressing (Die Warmfestigkeits-Eigenschaften der Elektron-Legierungen bei statischer Zugbeanspruchung) H. VOSSKÜHLER. *Metallwirtschaft,* Vol. 17, Sept. 2, 1938, pp. 935-941. Original research. Excellent compilation of the high temperature properties of standard Elektron (Mg-base) alloys. Tensile strength, yield strength, proportional limit, elongation, reduction in area and hardness are reported for each alloy for temperature ranging from 20° to 300° C. The alloys were studied in 3 conditions: Sand cast, permanent mold cast and extruded. Various heat treatments that affect the microstructure have no influence on the high temperature properties above 200° C. No differences in properties was discerned for permanent mold and sand castings above 150° C. Extruded stock is no stronger than cast material at temperatures over 200°-250° C., though the high temperature ductility is considerably greater in the extruded alloy. The addition of Al to Mg enhances the high temperature properties of the alloy, while the addition of Zn to binary Mg-Al alloys within the amounts present in commercial alloys exerts no influence on the high temperature properties. GA (10c)

Impact Strength of Metallic Materials at Low Temperatures, down to Temperature of Liquid Hydrogen (Die Kerbschlagzähigkeit metallischer Werkstoffe bei tiefen Temperaturen bis zu Temperatur des flüssigen Wasserstoffes) G. HAUPT & A. KRISCH. *Naturwiss.,* Vol. 26, June 17, 1938, pp. 390-393. Research. Results are given in the Table:

Material	Charpy Impact in m-kg./cm.^{2} + 20° C.	— 253° C.
99% Ni	32	22
Steel with 0.11% C, 17.7% Mn, 9.9% Cr, 1% Mo	33	22
Steel with 0.13% C, 15.5% Mn, 14.2% Cr, 1.1% Ni, 0.1% Mo	29	22
Steel with 0.11% C, 17.7% Cr, 8.5% Ni, 1% W, 0.2% Mo, 0.2% Ti, 0.2% Cu	24	20
Steel with 0.10% C, 18.0% Cr, 8.1% Ni, 0.5% Ti, 0.3% Mo	26.5	14.5
Steel with 0.04% C, 36.0% Ni	21.5	13
99.96% Cu	10	13
Steel with 0.24% C, 25.0% Cr, 24.4% Ni	15	10.5
Steel with 0.09% C, 9.4% Mn, 16.9% Cr	20.5	8
Steel with 0.08% C, 3.2% Si, 17.2% Mn, 7.7% Cr, 0.1% Ni	16.5	4
Commercial Pb	2	4
Steel with 0.41% C, 1.7% Cr, 0.4% Mo, 0.25% V	15	2

JZB (10c)

11 · CORROSION AND WEAR

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

The Electrochemistry of Corrosion. R. H. BROWN & R. B. MEARS (Aluminum Res. Labs.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 2, 19 pp. Original research. The corrosion of Al in chloride solutions is electrochemical in nature. The corrosion of oxide-coated Al occurs in the form of small isolated pits. The total current flowing between pitted and uncorroded areas is directly proportional to the cathodic area and nearly independent of the anodic area. An increase in the number of pits (anodic areas) will not increase the corroding current, but will reduce the current density on these anodic areas and, hence, also the intensity of attack. The measurement of the potential of a corroding specimen does not give information concerning the intensity of corrosion, as the potential depends on the number of breakdowns and on the type of solution. In a chloride solution the first breakdown of the oxide film is indicated by a change of potential, but further breakdowns cause little change in the potential. The potential of a specimen corroding in K_2SO_4 solution gradually becomes more negative as the breakdowns increase. The measurement of the current flowing in a corrosion cell, by the method of shorting the cell through an ammeter, sometimes gives less than the true short circuit value, because of the resistance of the ammeter. This objection is obviated by a "zero resistance" method which uses an external source of e.m.f. to bring the anode and cathode to the same potential against the solution. The current flowing at this point is the corroding current. **A Theory of Cathodic Protection.** R. B. MEARS & R. H. BROWN. *Ibid.*, Preprint No. 3, 9 pp. Original research. According to the electrochemical theory of corrosion, a potential difference is set up between adjacent areas of a metal because of heterogeneities of the surface or of the medium. The system resembles a short circuited cell, in which the negative electrode corresponds to the corroding or anodic areas, and the positive electrode corresponds to the cathodic or uncorroded areas of the metal. The flow of current causes attack only of the anodic areas. It polarizes the cathodic areas until the potential of these areas against the solution is the same as the potential of the anodic areas against the solution. The freely corroding current is determined by the current density required to polarize the cathodic areas until they have the same potential as the anodic areas. The current density (applied by an external e.m.f.) required to prevent attack of a metal must be high enough to polarize the cathodic areas until they gave the same potential (against the solution) as the static potential of the anodic areas. In experiments with Zn and Cu electrodes, the Cu electrode was cathodically polarized with the aid of an auxiliary Pt electrode until its potential was the same as that of the Zn electrode. Under these conditions no corroding current flowed between the Zn and Cu. AB (11)

Examination of a Sheet of Aluminum Exposed for 40 Years in an Urban Atmosphere. CARLO PANSERI. *J. Inst. Metals*, Vol. 63, 1938, Advance Copy 802, 6 pp. The Al examined was a sheet originally 1.3 mm. thick installed on a cupola of a church in Rome in 1897. The metal was of low quality, containing 1% Si and 0.6% Fe, probably of Swiss origin, and shows the characteristic microstructure for such material in the half-hard condition. Some parts of the sheet were practically unaffected by the exposure, and the corroded zone was no more than 0.05-0.15 mm. deep. Tensile properties were comparable with unexposed material of same analysis. Lack of severe corrosion was attributed to design and ventilation of cupola, which have prevented accumulation of water. JLG (11)

Thermomagnetic Study of Rust (Étude Thermomagnétique des Rouilles) ANDRÉ MICHEL & MARGUERITE GILLISOT. *Métaux et Corrosion*, Vol. 13, Aug. 1938, pp. 144-146. Original research. Thermomagnetic methods permit following the process of crystallization (ferrites, oxides), in detail. In the present study, a recording thermomagnetic apparatus, Chaudron-Forester type, was used. The Fe rust is considered to consist of a mixture of oxides (magnetite, cubic sesquioxide) and hydrates (monohydrate $Fe_2O_3 \cdot H_2O$ occurring as goethite and lepidocrocite). Thermomagnetic analysis distinguishes between goethite and lepidocrocite, since on dehydration lepidocrocite changes to strongly ferro-magnetic cubic Fe_2O_3, whereas goethite changes to slightly ferro-magnetic rhombohedric Fe_2O_3. An Fe rod covered with tar and subjected to seawater corrosion, when examined thermomagnetically, exhibited tar anomalies; (1) Dehydration of the rust, and (2) a reduction by the organic impurities. The sesquioxide was reduced to Fe_3O_4, thus increasing the magnetization. Thermomagnetic analysis is a rapid method for detecting the presence of lepidocrocite in rust. X-ray examinations revealed that the cubic sesquioxide consists of extremely fine grains. 7 references. GTM (11)

Cracking of Steel in Ammonium Nitrate Solutions. W. ANDREWS. *Metallurgist (Suppl. Engineer)* Aug. 1938, p. 160. Letter to the editor. Reports results of examining, metallurgically, samples of mild steel equipment that had failed while handling solutions of nitrates. Failures were confined to mild steel equipment in which calcium and ammonium nitrates were handled; equipment handling sodium nitrate appeared to be immune. Microscopic examination suggested that the intercrystalline attack was connected with chemical attack on the iron carbide in the steel, when located in or contiguous to the crystal boundaries. It was also noted that only those liquors containing ammonium nitrate, *i.e.* calcium nitrate containing some ammonium nitrate and ammonium nitrate itself, caused disintegration to occur and if the solution were free of ammonium nitrate, *e.g.* the sodium nitrate solution, no trouble was experienced, even in riveted joints. Experiments on pure iron carbide indicated that ammonium nitrate was the bad actor, according to the equation: $15\ H_2O + 3\ NH_4NO_3 + 4\ Fe_3C = 12\ Fe(OH)_2 + 6\ NH_3 + 4\ C$. VVK (11)

The Low Temperature Oxidation of Iron. H. R. NELSON (Battelle Mem. Inst.) *J. Phys. Chem.*, Vol. 6, Oct. 1938, pp. 606-611. Original research. Electron diffraction study of the oxide films formed on an abraded (Armco) Fe sample by heating in air at 80°-260° C. showed no structural effects due to a "critical temperature" in the neighborhood of 200° C. α-Fe_2O_3 was found on samples oxidized above 130° C. provided the oxidation time exceeded a minimum value, which depends on temperature. Thus, 1 hr. at 180° C., 4 hrs. at 165° C., 13 hrs. at 150° C. or 1000 hrs. at 130° C. are just sufficient to produce a well-defined diffraction pattern. Lower oxidation temperatures or shorter times tend to strengthen the diffraction pattern due to the primary oxide film (γ-Fe_2O_3 or Fe_3O_4). This is not accompanied by appreciable grain growth, and traces of Fe are present in the pattern after oxidation periods as long as 1700 hrs. at 120° C. or below. It is estimated that the primary oxide film cannot be thicker than about 200 A.U. over some portions of the abraded surface. Above 193° C., a new α-Fe_2O_3 film appears, which is more coarsely crystalline and has a different type of preferred orientation than the first-formed α-Fe_2O_3 film. This secondary film may be formed by the outward diffusion of Fe through the oxide layer. The axis of preferred orientation of the α-Fe_2O_3 is always symmetrical about the normal to the surface. This orientation cannot be ascribed to pseudomorphism of the oxide crystals on the underlying Fe, as is the case with the primary oxide. EF (11)

A Search for an Alloy Resistant to Hydrochloric Acid Corrosion. K. T. VASHENKO. *Zhur. Khim. Prom.*, Vol. 15, No. 2, 1938, pp. 39-47. In Russian. Laboratory and commercial operating tests demonstrated that Fe-Si alloys containing Mo resist corrosion by HCl of all concentrations and at all temperatures up to boiling. The most resistant composition was 14-16% Si and 3-4% Mo. The corrosion resistance of alloys within this range is 8-10 times higher than alloys containing the same amount of Si, but no Mo. Hardness as well as acid-resistance increased with rise in Si and Mo contents. Na (11)

12 · GENERAL

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

Sintered Metals (Sinter-Metalle) H. E. HONISCH. *Chem. Z.*, Vol. 62, Nov. 16, 1938, pp. 829-831. Practical discussion of powder metallurgy. The advantages and applications are illustrated by high-melting metals, such as Mo, W, Ta and Os whose casting is not practical, and carbides used for cutting tools. Sintering is defined as heating of granular material (such as ceramics or metals) close to the melting point so that surface softening and fritting occur. The grains stick together, forming a more or less porous skeleton of an unmelted and chemically unchanged material. Methods of production of metal powders are: (1) Reduction of oxides by means of H_2, CO, or admixed C (soot, graphite); this is applied for W, Mo, Co, Ni, Fe. (2) Deposit of metals from salt solution by means of liquid or solid reducing agents; this is applied for Ti. (3) Precipitation of metal powders from carbonyls. (4) Mechanical disintegration of metals. (5) Spraying by the electric arc. Homogeneity of the powders and uniform grain size are required, and are best obtained by chemical processes. Otherwise, mechanical separation by screening, elutriating or air sifting is necessary. The production of sintered metals starts with the pressing operation. Pressures of 1,000-5,000, sometimes even 10,000 atmospheres (15,000-70,000, 150,000 lbs./in.^{2}, respectively) are used. High pressures produce greater wear on the dies. After compression, pieces possess enough strength to permit them to be handled. The next step is presintering, usually in an electric furnace at 300°-1500° C., depending upon materials used, which gives a product that can be machined. A second sintering gives the final strength, hardness and characteristic properties. When using carbides, additions of binder metals are made, to improve machinability and reduce brittleness. Co or Ni in amounts up to 20% are used. Temperatures are high; C-short circuit or high-frequency furnaces, or sometimes Mo-or W-wound resistance furnaces, are used. The effect of the binder is explained by its cementing action, which results in a mechanical mixture with some alloying at the grain interfaces. The wide application of the sinter process is justified by the hardness obtainable, corrosion resistance and, in many instances, economy. W-wire, widely used as filament in electric bulbs and heating elements, is made by pressing, swaging and stretching under heat (electric current flows through piece), drawing through diamond dies. Surgical instruments can be made from Ta powder. Fe powder is used, *e.g.* for magnetic cores. High-purity Fe powder (*e.g.* carbonyl-Fe) can be sintered in molds without previous pressing. Sheet metal rolled from a sintered block shows excellent deep-drawing properties. By means of additions, Fe alloys with exactly predetermined characteristics (*e.g.* coefficient of expansion) can be produced. The application of oil-less bearings is mentioned. [The development in the field of sintered metals is proceeding rapidly and is becoming highly specialized. This article contains only some examples of the process and of its applications.—R. P. S.] RPS (12)

Defects in Steel. JOSEPH A. DUMA (Norfolk Navy Yard) *Heat Treating Forging,* Vol. 24, Mar. 1938, pp. 120-125, 142; Apr. 1938, pp. 174-178, 181; May 1938, pp. 231-236; June 1938, pp. 280-285, 298; July 1938. pp. 333-338, 350; Aug. 1938, pp. 393-396; Sept. 1938, pp. 454-458; Oct. 1938, pp. 504-506. Comprehensive summary of inherent and acquired surface and subsurface defects in steel, omitting those properly the problem of the open-hearth department. Defines each defect and discusses its causes, remedy and detection. Some of the information given is original. Among the subjects treated are forging bursts and cracks; burning and overheating; forge cooling cracks; worm-holes; laps; scaling; flow lines; banding; seams; splits; decarburization; "lip"; mechanical pipe; carbide, blue and secondary brittleness and transformation shortness; quenching and shatter cracks; effect of heat treating processes; grain size; brittleness; methods for discovering defects; zoning; "fire-crock"; "chill"; carburizing defects; nitriding failures; flame hardening; straightening cracks; H_2 embrittlement; pickling defects; welding defects such as undercutting, overlapping, porosity, inclusions, bird-eyes, cracks and decay; testing soundness of welds; brazing; tool, drag and score marks; grinding cracks; stress raisers; surface defects on rolled sheet and strip such as clouds, laminations, blisters, kinks, exfoliation, non-uniform reduction, cracks, ripples, roughening and "Dutch-bending"; intergranular, intercrystalline, Stead's and Sauveur's brittleness; tears from deep drawing; stretcher strains; caustic embrittlement; corrosion fatigue; electrochemical theory of corrosion; protective coatings; intergranular corrosion of stainless steel; corrosion tests; season cracking; heat checks; Zn embrittlement; and failure due to absorption of N_2 when lubrication fails. Includes over 60 references. MS (12)

World's Platinum; Post-war Changes in the Industry. *Chem. Trade J.,* Vol. 103, July 8, 1938, p. 28. From *Economist,* June 25, 1938. Before the World War, Russia supplied 90% of the world's output of Pt, and Colombia the bulk of the remainder. These countries were the most important producers until 1925, though Russian output fell heavily after the Revolution. In 1924, the price was £29 per troy oz., and jewelry trade accounted for more than half of annual estimated demand of 200,000-225,000 oz. After 1924, Transvaal deposits were developed rapidly, so that production in 1930 exceeded that of Colombia. After this, South African supply fell, owing to technical difficulties connected with treatment of ore. Canadian production has increased from less than 17,000 oz. in 1925 to 259,000 oz. in 1937, the latter being considerably more than half the output of these 4 countries. Bulk of Canadian output is a by-product from Ni-Cu ore of Frood mine. Producer, whose direct costs of refining Pt are 7-8s. per troy oz., has encouraged the fall in price (now about £7 per oz.), and has carried out research on possibilities of Pt as an industrial metal, so that a large increase in supplies could be absorbed. As a result, world consumption was about 450,000 oz. in 1937. According to U. S. Bureau of Mines, jewelry trade consumed about 36% in 1936; dentistry, 25%; electrical industry, 14% and chemical industry, 13%. MS (12)

Annual Report of the Metallurgical Division, Fiscal Year 1937-38. R. S. DEAN & OTHERS. *U. S. Bur. Mines Rept. of Investigations* 3419, Oct. 1938, 80 pp. Technical data secured by the Metallurgical Division during 1937-38 in the following investigations are summarized: Measurement of specific heats at low temperatures; measurements of heats of formation and free energies; production of pure sponge Cr at low temperatures; mechanical concentration or unmixing of gases; settling smoke with sound waves; electrolytic Mn; electro-refining of Sb and treatment of Au-Sb ores; alunite extraction; Mg from magnesite; grinding studies; concentration of Fe ores, chromite, a Tenn. Mn ore and an Ill. Pb-Zn-fluorspar ore; flotation of non-sulphide minerals; development of wetting agents for flotation; ore testing projects (14); treatment of Au ores (5); studies of concentrating problems of Mountain City Copper Co., Sunnyside ore, U. S. Smelting, Refining & Mining Co., and Magma Copper Co.; recovery of Pb and Ag from oxidized ores by flotation; microscopy of Tintic ore; improvement in sulphidizing; flotation of oxidized Cu minerals; sintering; Au loss in dredging; recovery of Au in pyrite or base-metal ore; flotation of Ag minerals; flotation of scheelite; analytical investigations; recovery of S from smelter smoke; desulphurization of pig Fe with CaC_2; equilibrium conditions in desulphurizing reactions; coercive-force measurement of C in steel; magnetic behavior of open-hearth slags; metal-slag dispersion. AHE (12)

A Further Study on the Theory of the Change in Electric Resistance in Metals Due to Hydrostatic Pressure. KÔTARÔ HONDA & TOKUTARÔ HIRONE. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1292-1293. In English. Original, theoretical research. The different types of change in electric resistance in metals by the action of extra-high hydrostatic pressure, recently observed by Bridgman (*Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 730L/3) are explained by the authors' previously advanced theory of the nature of free electrons (*Z. Phys.,* Vol. 76, 1932, p. 80). For many metals the calculated results agree satisfactorily with experiment, but for a few metals a further approximation for the calculation of mean free path of electrons is required. The latest calculations satisfactorily explain the new Bridgman data on Cu, Ag, Au, Fe, Pb, Li, Na and Cs. EF (12)

Announcing

SAMPLING AND ANALYSIS OF CARBON AND ALLOY STEELS

Prepared by the Chemists' Committee of The Subsidiaries of the U. S. Steel Corporation

EXACT CHEMICAL SPECIFICATIONS govern the manufacture and purchase of steel products. To insure compliance with these specifications, standardized and minutely accurate analytical procedures are essential. The necessity for standardization of methods becomes evident when it is realized that corrosion and heat resistance and other specific properties, are obtained by the addition to steel of such elements as nickel, chromium, molybdenum, etc., sometimes in almost microscopic percentages. When determinations accurate to the third decimal place are demanded, no tolerance can be allowed for the slightest variation in procedure.

AUTHORITATIVE AND DETAILED PROCEDURES are simply and lucidly presented in this volume. Its aim is to enable any chemist to analyze steels with meticulous accuracy, and it accomplishes this aim by eliminating as far as possible the "human equation." Careful observance of the directions and cautions given will not only reduce the time of determination to a minimum, but will yield absolutely reliable results. This will be of tremendous value to the relatively inexperienced chemist who may have occasion to make check analyses of steel shipments. Since large-scale production of alloy steels is a comparatively recent development, the need for authoritative methods is greater now than ever before, and will be constantly increasing. Everyone interested in testing and analytical work should possess this volume.

SUBSIDIARIES OF THE U. S. STEEL CORPORATION have developed many new methods over a period of years. Their book, 356 pages in length, comprises the most complete and modern body of information on steel analysis that has ever appeared. This corporation has long been prominent in making available to industry everywhere information dealing with sampling and testing of materials used and produced in the iron and steel industry. Eight volumes, totalling 17 editions, published directly by the U. S. Steel Corporation at intervals during the last 30 years, have met an enthusiastic reception the world over, not only within the industry but in scientific libraries and universities. The Reinhold Publishing Corporation has been entrusted with the publication and sale of this latest volume.

THE SCOPE OF THIS BOOK *includes approved procedures for sampling mill products, and for determining all the elements that may occur in steel under any conditions of combination. Methods are given for such infrequently* occurring elements as beryllium and cerium. The first appendix article describes three recent new procedures for determination of sulfur by combustion, most desirable when it is impossible to obtain the sulfur content by older methods. The skeleton table of contents below gives a general summary of the subjects covered.

Because of the extent of the full Table of Contents, only Chapter Headings are given.

Sampling.
Qualitative and Quick Tests for Identifying Various Types of Steel.
Methods of Analysis.
Chemical Separations.
Determination of Manganese.
" " Phosphorus.
" " Sulphur.
" " Silicon.
" " Copper.
" " Nickel.
Determination of Chromium.
Determination of Vanadium.
" " Molybdenum.
" " Titanium.
" " Aluminum.
" " Arsenic.
" " Tin.
" " Cobalt.
" " Tungsten.
" " Uranium.
" " Zirconium.
Determination of Columbium and Tantalum.
Determination of Selenium.
" " Boron.
" " Beryllium.
" " Nitrogen.
" " Antimony, Copper and Molybdenum.
" " Zinc.
" " Cerium.
Appendix I: Determination of Sulphur or Carbon and Sulphur by Combustion in Oxygen.
Appendix II: Discussion of Methods for Oxygen, or Oxygen, Hydrogen and Nitrogen in Steel.
Appendix III: Preparation, pH Ranges, and Color Changes of Various Organic Chemical Indicators.
Appendix IV: Table of Atomic Weights, Atomic Numbers and Other Physical Constants of the Elements.

356 Pages **33 Chapters** **Apparatus Diagrams** **$4.50**

REINHOLD PUBLISHING CORP., 330 W. 42nd Street, New York, U. S. A.

books

National Advisory Committee for Aeronautics, Twenty-fourth Annual Report

Supt. of Documents, Washington, D. C., 1938. Paper, 9 x 11¼ in., 47 pages. Price $.20.

Metallurgical investigations form a very small proportion of those undertaken, compared with those dealing with aerodynamics and the mechanical problems of the power plants. Problems studied that involve metallurgy were, continuation of study of corrosion resistance of alloys of Al and of Mg, effect of subzero temperatures on welded structures (classed as important), evaluation of elastic properties of 18:8, use of stainless steel ignition cable to reduce capacitance, properties of beryllium copper and phosphor bronze for instrument diaphragms, effort to detect deterioration by fatigue in aircraft propellers (no sign of deterioration appears short of an actual crack), determination of crinkling and bending strengths of aircraft tubing, development of a pack method for determining properties of thin sheet under compression, and a method for study of cylinder wear by noting the decrease in size of diamond point impressions.—H. W. GILLETT.

Hardening and Annealing of Steel *(Härten u. Vergüten des Stahles) 4th Edition.*

Hugo Herbers

Verlag Julius Springer, Berlin, 1938. Paper, 6¼ x 9 in., 68 pages. Price 2 RM.

This is No. 7 in the Werkstattbücher series of H. Haake, of which this edition comprises the 25th to 31st thousand. It is a concise, well-written and well-illustrated elementary discussion of heat treatment of carbon and alloy steels, in which the fundamental principles are set forth in such fashion as to lead up logically to their practical application. Although it covers microstructure and property charts in the usual terminology of the metallurgical engineer, it is meant for the education of the "man at the furnace" *(der Mann am Ofen)*, since he can understand what he is trying to accomplish only when he grasps the scientific essentials. Hence it does not hesitate to show space lattice diagrams along with discussions of distortion on quenching.

There are many books dealing with the same field, but few do as complete a job in such small compass. For those who read German it is a very good introduction to the subject. For those who want to learn to read metallurgical German it is a good pamphlet for such study, since it is written in relatively easy German.—H. W. GILLETT.

Sampling and Analysis of Carbon and Alloy Steels

U. S. Steel Corp. Chemists

Reinhold Publishing Corp., New York, 1938. Cloth, 6¼ x 9¼ in., 356 pages. Price $4.50.

Few steel analysts are unfamiliar with the two former booklets of the United States Steel Corp. dealing with methods of sampling and analysis for plain carbon steels and alloy steels used by the chemists of that organization. All analysts familiar with the former booklets will welcome the news that the complete methods as revised to 1937 are now available in book form. The book includes the result of more than two years' cooperative effort of the chief chemists of the various works and research laboratories of the corporation.

Analysis of the usual elements as well as of the less common alloy constituents and impurities are given. The methods are all tested and proved in the corporation's laboratories. The reviewer during the past several years has used many of the methods outlined and has had the opportunity to test others, and highly recommends the new book to all steel analysts. While it is not a textbook, teachers of analytical chemistry will find it a valuable reference book especially for courses in advanced analysis. Chemists and metallurgists not engaged in analytical work will find in the section, "Methods Available," under the determination of each element discussed, some sound chemistry that they may have forgotten. An evening's reading of these sections is recommended.—JOHN D. SULLIVAN.

Chemical Analysis Methods (Umpire) for Aluminum and its Alloys

(Chemische Analysen-Methoden. Schieds Analysen)

P. Urech

Aluminium-Zentrale G.m.b.H., Berlin, 1938. Cardboard, 6 x 8½ in., 68 pages. Price 5 RM.

This book is a German translation of the original French edition edited by the Bureau International des Application de l'Aluminium, Paris. The contents are divided into the following parts: The sampling and preparation of samples for chemical analysis; the preparation and standardization of solutions for volumetric analysis; methods for analyzing aluminum and aluminum alloys, respectively; and schematic methods of analysis.

In general, the methods are well organized. Each method is introduced by a summary and a list of the reagents required. Then follow details of the method, and lastly notes on the method. Methods for only the common impurities and alloying elements for aluminum are included; thus procedures are not given for V, Na, Ag, Ga, Co, Be, Sb, which appear occasionally as impurities or alloying elements.

The method described for zinc is unique and interesting, as the precipitated $ZnHg(CNS)_4$ is determined by titration with KIO_3 solution. It is rather irritating to find the reaction poorly written and improperly balanced.

The Volhard method for manganese is presented as an umpire method. The reviewer feels that the gravimetric precipitation of manganese as manganese ammonium phosphate is inherently more accurate and should be preferred. In any case, ordinary aluminum alloys do not require separation of the manganese prior to titration by the Volhard method.

In the section on preparation and standardization of solutions, several methods are given for standardization of a single solution. The reviewer feels that a book concerning itself with umpire methods of analysis should also adopt the most accurate method of standardization of a solution and not give a choice of 4 methods, of which one may be questionable.

The book is easy to read and should be read by anyone interested in the analysis of aluminum and its alloys.—A. E. PAVLISH.

Journal of the Electrodepositors' Technical Society.—

Vol. 14

Electrodepositors' Tech. Soc., London, 1938. Cloth, 5¾ x 8¾ in., 252 pages. Price 1 guinea.

In recognition of the need of electroplaters for application of the more advanced technical knowledge available today, the 26 practical papers in this volume, together with their discussions, present the more recent developments in commercial plating. Considerable space has been devoted to explaining and evaluating various methods of measuring thickness and testing electro plates, referring to drop tests, bend tests, magnetic tests and stripping. The methods are critically discussed in relation to practical use in specification plating.

Plant practice and experiences in nickel and bright nickel plating in England are treated in some detail. In the latter cases, the Schlötter, Weisberg and Stoddard, and the Hinrichsen processes are shown to have given satisfactory performance in manual, semi-automatic and fully automatic application.

Electro-refining of copper, the problem of patents, and anodizing of aluminum are summarized, and should prove instructive reading.

In general the material should be of interest to platers and engineers because of the practical aspect of the treatment of the subjects and the discussion of the various papers by men experienced in the plating industry in England. The American reader should probably keep in mind that the evaluation of product quality as related to production economics is no doubt based on somewhat different methods and factors than those that exist in the United States. The methods used in this country, not being widely known in England, apparently have led some authors to a misunderstanding of the quality of production plating in the United States.—C. L. FAUST

U. S. S. Carilloy Steels

Carnegie-Illinois Steel Corp., Pittsburgh, 1938. Cloth, 6 x 9 in., 214 pages.

This bears some similarity to handbooks dealing with alloy steels previously put out by Bethlehem, Republic, International Nickel Co., Vanadium Corporation of America and Climax Molybdenum Co. Large charts on hardenability, the S curve and grain size are included, and the discussion of these fundamentals is outstanding. That on machinability is also of interest.

The usual property charts for S.A.E. steels are included, together with bar charts of core properties of carburizing steels. Stainless steels are not included. A particularly valuable section is that dealing with the gradations within and between the compositions of the S.A.E. steels, in individual specifications of General Motors, Ford and Chrysler.

The ultimate purpose of handbooks of this type is to sell steel, and specifically the steels made by, or using the elements sold by, the firm that prepares the book. Possibly there comes in also the aspect of self-protection against complaints that would be avoided by more understanding of fundamentals and hence, more intelligent use by the purchaser. At any rate, the dissemination of sound technical information is considered so important that such handbooks have ceased to be mere catalogs and reiterations of the virtues of "Three Star Double Extra" brand, and contain not only data but discussions of metallurgical principles that are often far from being kindergarten subjects. These discussions must be brief, clear and correct, for the prestige of the firm is involved. Few text books are written with the care for correct phraseology that one meets in these books. Consequently, the student as well as the practicing metallurgist values them highly—and they deserve to be highly valued.—H. W. GILLETT.

Aluminum Bronze

Copper Development Assn., London, 1938. Cloth, 6 x 8½ in., 150 pages. Free to those "of responsible status and genuine interest."

This is another (Publication No. 31) of those authoritative little books on copper alloys issued by the British Copper Development Association. It has much the same form and arrangement as did "Copper in Cast Steel and Iron," which was published in '37. If we may expect an analogous publication on each class of important copper base alloy every year, a decided metallurgical need will be met. The "Alloys of Iron" monographs have accentuated the lack of similar treatment of alloys of copper.

The approach is an engineering rather than a sales-propaganda one. Limitations are pointed out as clearly as are advantages.

Starting with the equilibrium diagram, physical and mechanical properties of the straight copper-aluminum alloys are given in Chapter 1. Chapter 2 deals with α copper-aluminum and copper-nickel-aluminum alloys for cold working; Chapter 3 with those of duplex structure for hot working, and with their heat treatment and resulting properties. Casting alloys, corrosion-resistance, production and fabrication of sand, die and centrifugal castings, Durville pouring for ingots, hot and cold working, joining and machining, take up the next three chapters. A brief final chapter deals with industrial applications, though many of the 83 illustrations that were scattered through the previous chapters showed industrial uses of the materials there discussed. A bibliography of 211 references covering 1927-1938, and a summary of specifications, follow.

This "clear, concise, complete" monograph is a valuable addition to any metallurgical library. Its detached, judicial attitude, stating useful properties without flag-waving and with full recognition of drawbacks and limitations, might well be emulated by other groups who prepare the handbook type of publicity for their products. The metallurgical engineer who uses this will appreciate the spirit in which the facts are presented, as much as the facts themselves, for the un-named author recognizes that his readers are intelligent, reasoning beings who are repelled rather than attracted by the extravagant phrases so often found in publications of this sort. One would guess that the book was written by a metallurgical engineer without "benefit" of a rephrasing by an advertising man, for there is inherent evidence throughout of unflavored engineering truth.—H. W. GILLETT.

Metallurgy *(Metallurgie)*

R. Cazaud

Dunod, Paris, 1939. Cloth, 4 x 6 in., 328 pages. Price 25 fr.

Somebody must want a handbook of this nature since this is the 55th edition. However, the contents are sketchy and often out of date, only half a dozen pages of new or revised matter being any different from the previous edition. In a few tables of statistics, 1938 data have been included. As an example of the poor balance characteristic of the handbook, an alloy of 80 Ni, 14 W, 6 Zr is listed as a cutting tool while carbide tools are dismissed with one sentence to the effect that sometimes tools are made of tungsten carbide.

It would seem that anyone who had any need for a metallurgical handbook would need a better one than this, and that anyone having one edition of this would not want another for at least 5 years. At any rate, the English-speaking reader will not find it worth the cost.

Another Dunod handbook *(Automobile Handbook,* 27th Edition, 488 pages, 3¾ x 4½ in., 25 fr.) just published, has a metallurgical section of some 65 pages, consisting chiefly of a listing of various alloy steel compositions supplied by several French steel makers. In general, the comments made on the metallurgical handbook apply also to this.—H. W. GILLETT.

CURRENT news

The William Campbell Fellowships

Through the bequest of the late William Campbell, for many years Howe Professor of Metallurgy at Columbia, there have been established the "William Campbell Fellowships" primarily for scientific research in the field of metals. These fellowships become available for the first time for the academic year 1939-40 for graduate study and research at Columbia University. They carry stipends up to $1200 per annum as determined by the Campbell Fellowship Committee.

Applications accompanied by certified transcripts of academic records, proposed research projects and proposed fields of graduate studies should be filed with the Dean of Engineering, Columbia University, New York City, before March 15, 1939. Announcements and application blanks will be forwarded to interested persons upon application to the same address.

A Powerful Magnet

The most powerful permanent magnet in the world, one that will lift nearly 1500 times its own weight, has been developed in the research laboratory of the General Electric Co. by W. E. McKibben.

The magnet weighs 1.85 grams, 1/250th of a pound, and has been made to lift 2750 grams in tests. About half the size of an eraser on the end of a pencil, it will lift a 5-lb. flatiron with ease. The new magnet is several times as strong as those previously made.

The magnet is made of a material known as "Alnico," an alloy of aluminum, nickel, cobalt and iron. It was first developed in the General Electric research laboratory as a heat-resisting alloy which resisted scaling and deterioration at high temperatures. Research on the magnetic properties of alloys of this type was later carried on by Prof. T. Mishima of the Imperial University, Tokyo, and General Electric perfected a process of heat treating by which the magnetic properties were more fully developed.

Alnico has been used in radios, motors, generators and other electrical equipment for some time, replacing electromagnets which require current. The new magnet developed by Mr. McKibben employs the same alloy as previously used, but utilizes a steel sheath around the Alnico pellet to direct the magnetic flux against the keeper or object being attracted. The steel jacket also protects the magnet against demagnetization when not in use.

Malleable Founders' New Activity

Through Robert E. Belt, secretary-treasurer, the Malleable Founders' Society, Cleveland, announces the recent appointment of James L. Cawthon, Jr., to its full time staff in the capacity of development engineer. A new activity of the society occasions the announcement. Included in this new service will be the furnishing of technical data to users of malleable castings, development of new uses for the material, and other services to users and Society members coming under the head of general product development engineering.

Enrique Touceda, professor of metallurgy, Rensselaer Polytechnic Institute, Troy, N. Y., author of numerous contributions to the literature of iron and steel metallurgy, and one of the outstanding metallurgical authorities of the world, is consulting engineer to the society.

James H. Lansing, shop practice engineer, has been engaged in the malleable iron industry in technical, production and executive capacities for the past twenty years. Mr. Lansing's activities are mainly in connection with maintaining quality standards.

James L. Cawthon, Jr., development engineer newly appointed, has been identified with the iron, steel and foundry industries for the past 19 yrs. His experience has included engineering, production, sales and advertising, and executive activities. He has been associated with Pittsburgh Electric Furnace Corp., General Motors Corp., the Bonney-Floyd Co., American Steel Foundries, and Continental Steel Foundries. In addition to general duties listed above, he will also carry on the society's cooperative educational work with technical schools in the country.

A. I. & S. E. to Meet in Birmingham

Fred M. Sturgess, chairman of the Birmingham section of the Association of Iron and Steel Engineers, has announced the official program for the annual spring conference of the association, which will be held in Birmingham, Ala., March 27 and 28. Mr. Sturgess, who is master mechanic and chief electrician for the Fairfield Wire Works of the Tennessee Coal, Iron and Railroad Co., states that the technical sessions will be held in the headquarters, the Hotel Tutwiler.

As customary, inspection trips will be conducted to plants in the area of this national meeting. Monday afternoon, a trip will be made through the plant of the American Cast Iron Pipe Co. Tuesday, the entire day will be spent inspecting the vast properties of the Tennessee Coal, Iron & Railroad Co.

Social activities will include a Luncheon at 12:30 P. M., Monday, in the Hotel Tutwiler. A. B. Haswell, assistant to the vice-president, Tennessee Coal, Iron and Railroad Co., will be the speaker. In the evening an informal dinner will be held, at which Robert Gregg, president of the Tennessee Coal, Iron & Railroad Co., will be the principal speaker.

Steel Institute Meeting on May 25

The forty-eighth general meeting of the American Iron and Steel Institute will be held at The Waldorf-Astoria, New York, on Thursday, May 25. Program of the meeting has not yet been announced. Attendance at all sessions of the meeting and at the banquet will again be restricted to individual members of the Institute.

● John R. Heckman has been appointed midwestern representative for The Electro-Alloys Co., Elyria, Ohio. He will make his headquarters at 122 South Michigan Ave., Chicago.

Advertisers' Index

Air Reduction Sales Company.....MA 157
Ajax Electric Company, Inc......Outside Back Cover
Ajax Electric Furnace Corporation...Outside Back Cover
Ajax Electrothermic Corporation
Outside Back Cover & MA 143
Ajax Metal Company.....Outside Back Cover
Alrose Chemical Company.....MA 165
Aluminum Company of America....MA 134, MA 135
American Bridge Company .....MA 141
American Car and Foundry Company.....MA 152
American Chain & Cable Company, Inc., Page Steel & Wire Division.....MA 161
American Electric Furnace Company.....MA 154
American Gas Association .....MA 153
American Gas Furnace Company .....MA 152
American Hot Dip Galvanizers Association, Inc. ...A 24
American Machine & Metals, Inc., Riehle Testing Machine Division .....MA 169
Arcos Corporation .....MA 156

Bliss & Laughlin, Inc. .....A 21

Carborundum Company, Refractory Division
Inside Back Cover
Carnegie-Illinois Steel Corporation.....A 2, A 3
Cleveland Twist Drill Company .....A 6
Climax Molybdenum Company
Insert between pages 102 and MA 127
Columbia Steel Company.....A 2, A 3, MA 141

De Witt Operated Hotels.....MA 164
Dietert Company, Harry W. .....MA 172
Dow Chemical Company, Dowmetal Division
Inside Front Cover
Driver Company, Wilbur B. .....MA 150
du Pont de Nemours N *Co., Inc., E. I., R. & H. Chemicals Department*.....MA 132

Electric Furnace Company .....MA 162
Electro Metallurgical Company .....A 25

Foxboro Company .....A 20

General Electric X-Ray Corporation.....MA 170

Handy & Harman .....MA 158
Hanson-Van Winkle-Munning Company .....MA 165
Hevi Duty Electric Company .....A 11
Hotel Adelphia .....MA 179

Inland Steel Company .....A 23
International Nickel Company, Inc. ....A 26, MA 133

Johns-Manville Corporation .....A 10, MA 150
Jones & Laughlin Steel Corporation...MA 128, MA 129

Kemp Manufacturing Company, C. M. .....MA 151

Leeds & Northrup Company.....MA 136
Leitz, Inc., E. .....MA 173
Lincoln Electric Company .....MA 160

Mallory & Company, Inc., P. R. .....A 18
Maurath, Inc. .....MA 159
Mechanite Metal Corporation .....A 28
Michiana Products Corporation .....A 7

Norton Company .....A 19

Olsen Testing Machine Company, Tinius.....MA 167

Page Steel & Wire Division, American Chain & Cable Company, Inc. .....MA 161
Pangborn Corporation .....MA 147
Pittsburgh Lectromelt Furnace Corporation.....MA 141

Republic Steel Corporation .....A 8, A 9
Riehle Testing Machine Division, American Machine & Metals, Inc. .....MA 169

St. Joseph Lead Company .....MA 131
Scomet Engineering Company .....MA 177
Scott Company, Henry L. .....MA 169
Spencer Turbine Company .....MA 149

Taylor Sons Company, Charles .....A 5
Teleweld Incorporated .....MA 168
Thermal Syndicate, Ltd. .....MA 174
Timken Roller Bearing Company Steel & Tube Division .....A 4

Union Carbide and Carbon Corporation .....A 25
United States Metals Refining Company .....MA 177
United States Steel Corporation ...A 2, A 3, MA 141
United States Steel Products Company A 2, A 3, MA 141

Wilson Mechanical Instrument Company, Inc...MA 168

Zeiss, Inc., Carl .....MA 175

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New Location for Alrose Chemical Co.

The manufacturing plant and laboratories of the Alrose Chemical Co. and Mark Weisberg Laboratories have recently moved from their former Providence, Rhode Island locations, 80 Clifford St. and 92 Printery St., to a new, enlarged factory at 180 Mill St., Cranston, R. I. The new plant, off Park Ave., has 40,000 sq. ft. of working space, with laboratories to accommodate 8 chemists.

The John P. Bonnett & Son Co., formerly owned by Mark Weisberg Laboratories, has been liquidated. Its operations in the electroplating of jewelry and novelties in precious metals have been discontinued in order that increased emphasis may be given by Mark Weisberg Laboratories to research and the development of new specialties for the metal and textile trades. Development of several new finishes is contemplated, also improvements in all methods of electroplating so that the demands for new styles and colors may be met more satisfactorily by manufacturing jewelers. At the new plant, a full line of synthetic chemicals for the textile industry, wetting agents, etc., will be produced as in the past.

Chrome-Magnesite Brick for Furnace Roofs

The recent Austrian development of a chrome-magnesite brick for open-hearth furnace roofs, ports and uptakes is the most important single advancement in open-hearth furnaces for many years, according to Lewis B. Lindemuth, consultant on steel production, New York. Last year he visited Germany and Austria to study this development and last fall he again went to Austria to see the latest improvements. He considers it important that all furnaces, now being built or projected, should take into account the probable change in the near future to basic refractories, so that provision can be made for such a change, without interfering with the immediate operation as a silica refractory furnace.

Bridgeport Brass's New Mill

Devoted exclusively to the production of brass, copper and copper-base alloys in sheets, rolls and strips, Bridgeport Brass Company's recently completed rolling mill is designed to utilize heavy cast bars in standard widths, with multiple slitting to provide any desired combination of widths.

The new mill, built as a part of a large expansion and modernization program, embodies in its design the straight-line production principle of materials handling.

The mill lay-out, developed by the company engineers, is planned so that the flow of production is uninterrupted and materials proceed in one direction up and down the four main bays of the building from the first breaking-down mills to the inspection and shipping of the finished material.

New Chairmen of A.I.M.E. Divisions

J. H. Nead, chief metallurgist, Inland Steel Co., Chicago, has been elected chairman of the Iron and Steel Division of the A. I. M. E. The new chairman of the Institute of Metals is R. H. Leach, vice president, Handy & Harman, Bridgeport, Conn.

● At the annual meeting of the Aluminum Association in New York, Charles B. Bohn, president of the Bohn Aluminum and Brass Corp., Detroit, was elected president to succeed Arthur Vining Davis who had been president of the Association since its formation in 1933.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 West 42nd Street, New York.*

POSITION WANTED: Electric steel melter, 9 years' experience Moore Rapid Electromelt furnaces, acid and basic processes. Laboratory experience. Able to take charge of melting and laboratory. Box MA-122.

POSITION WANTED: Powder Metallurgist. Four years' experience covering all phases from pilot plant production of powders and parts to pure research on fabrication and treatment. Graduate Chemical Engineering. Trained analyst and metallographer. Excellent references. Available immediately. Location immaterial. Age 25. Married. Box MA-123.

POSITION WANTED: Metallurgist, B. S. in engineering. Age, 30. Five years' experience in metallography, physical and steel analysis. For past 3 years metallurgist in charge of heat treat operations and laboratory testing in tractor and truck parts plant. Employed at present but available on 30 days notice. Box MA-124.

POSITION WANTED: Electrical and Metallurgical Engineer, M. S., 32 years. Broad experience: Ferro-alloys, electric arc and induction furnaces, automatic regulation, layout and maintenance; metallurgical processes. Excellent references, location immaterial. Box MA-125.

POSITION WANTED: Foundry metallurgist or melter metallurgist. B. Met. E. Melter, alloyed gray iron, one year; gray iron foundry metallurgist, one year; melter-assistant metallurgist, gray iron and high carbon steel foundry, three and one-half years. Experienced with operation and control of cupolas, Moore 'Lectromelt and Detroit Rocking Electric furnaces and the Brackelsburg furnace. Age 29. Married. Box MA-126.

POSITION WANTED: Professor of Metallurgy desires position for three months starting June first. The possibility of developing into permanent position of added interest. Ph. D. in physical chemistry and physical metallurgy. Four years of industrial experience and eight years of teaching experience in engineering schools. Will consider either teaching or industrial position. Box MA-127.

POSITION WANTED: Research Director. Executive engineer with outstanding record of widely used ingenious cost reduction methods, experienced in establishing better products from laboratory findings and coordinating new market uses in mechanical, electrical and chemical industries, is available to manage development program involving difficult processing, patent, and customer adaptation problems. Box MA-128.

POSITION WANTED: M. E. in engineering, major in metallurgy. Recent graduate with 18 months' non-ferrous experience. Will consider either industrial or teaching position. Box MA-129.

POSITION WANTED: Physical metallurgist. M. S. Age 26. Desires an opportunity in metallurgical development or control work. Good reference on past research experience. Box MA-130.

trends

by Edwin F. Cone, Editor

Lead in Steel

Is lead an alloying element in steel? This question has arisen because of the development last year of "Ledloy" which is discussed in the leading article in this issue. This is not fully answered but some significant trends are indicated, based on the research to date. Therefore it may be stated, say the authors, that lead is but an infant in the kindergarten of the alloying elements but, as regards screw stock, it is a lusty infant. They offer the hope that, as this infant grows and passes up through the grade and high schools, it may be graduated into an important alloying element in a much wider field such as the improvement in machinability of strong, heat-treated steels.

"Light" Steel Products

The trend in the American steel industry toward the manufacture of "light" steel products has been pointed out by the American Iron and Steel Institute. For the first 9 months of 1938, this type of steel—sheet, strip steel, wire products, tinplate, etc.—accounted for 45 per cent of the total output as against 42 per cent in the same periods during 1937 and 1936. This trend reflects the increased consumer demand for automobiles, farm and household goods, sanitary cans and similar products. The American capacity for strip steel production has expanded by leaps and bounds in recent years. In hot-rolled sheets and strip alone our output has doubled in 10 years—5,297,400 gross tons in 1927 and 10,735,000 tons in 1937.

Price Wars in Steel

Discussing the cessation late last year in the prospective price war in steel products, *Poor's Industry and Investment* says that "it is significant that cessation of the price war was largely a result of the unusual plea by important cussumers that quotations be restored to their former levels. These users saw that the entire industrial and business structure might be endangered by widespread uncertainty on the price of a product so important to our economy. It was realized that steel workers' wages would necessarily be reduced if price cutting continued unabated, and the market for users' products such as automobiles, would be curtailed." There was a reaffirmation of prices for the first quarter resulting in a sound price structure—a trend of decided general industrial benefit.

Open-Hearth Control

We were much interested in the announcement early this year of the development by the Steel Corporation of an equipment using an electric eye, or photo-electric control, as a means of keeping the temperature more uniform in the open-hearth furnace. It is claimed to be one factor in producing more uniform steel. We are reliably informed that all the new open-hearth furnaces built and put into operation last year have been more fully equipped with measuring, recording and controlling instruments than ever before. This all points to more complete control of open-hearth operations and probably better steel.

Steel Ingot Capacity

The ingot steel making capacity of the United States continues to rise. As of Dec. 31, 1938, the American Iron and Steel Institute figures this at 72,533,969 gross tons. A year earlier, or on Dec. 31, 1937, it was 71,065,640 tons. This is an increase of 1,468,329 tons or about 2 per cent. Most of this increase is naturally in open-hearth capacity. The trend in the increase in electric furnace capacity is interesting. Last year this capacity advanced over 15.5 per cent or from 1,331,124 tons to 1,540,255 tons. There must have been a substantial increase in the number of electric furnaces.

On the other side of the picture Bessemer capacity and that of the crucible process sharply declined.

Blast Furnace Capacity

Contrary to the trend in open-hearth steel ingot capacity in 1938, the capacity for producing coke pig iron declined from that existing at the close of 1937. At the end of 1938 the capacity was 49,252,120 gross tons or 407,480 tons less than the 49,659,600 tons on Dec. 31, 1937. This is somewhat surprising. One reason is probably found in the tendency to use more scrap in open-hearth charges than in earlier years.

Brass Die Castings

We referred last month to an address we heard on "Die Castings" by Charles Pack, vice-president, Doehler Die Casting Co. For some time we have been familiar with die castings of zinc, aluminum and magnesium base metals. Not many years ago, brass die castings were a new product. Mr. Pack stated that these had not been as successful as the others, due largely to the difficulty in finding a steel die that would have a long enough life. This problem is however nearing solution.

Exports of Scrap Steel

The exports of scrap iron and steel continued on a large scale in 1938. Data show that the total was over 3,003,500 gross tons which, while less than the 4,092,590 tons in 1937, is the second largest total on record. Japan is again the largest customer having taken about 1,400,000 tons last year as against 1,911,500 tons in 1937. Some contend that this trend is a menace to our supplies of raw material in case of war. The secretary of the Scrap Iron and Steel Institute states that no harm is involved in this movement, and offers data to prove his contention.

New Equipment and Materials

Rolls Repaired With Meehanite

A new method has been devised by Fulton Foundry & Machine Co., Cleveland, which permits the repair of broken roll necks by means of a special foundry burning technique. From 2 to 5 tons of Meehanite metal are used for each roll in order to make a good fusion to the roll body. Shown is a repaired back refiner roll used in a rubber reclaiming plant. In the foreground may be seen the broken roll neck which has been successfully replaced by the fusion process. The character of Meehanite

metal lent itself to the development of this process, and the fusion is carried out at a temperature slightly higher than the melting temperature of the parent metal in the rolls. So complete is the union that after grinding no dividing line is visible.

The roll shown is a 24-in. diameter by 36 in face back refiner roll used in conjunction with a somewhat smaller front roll; the rolls, in operation, being set close together and creating pressures of from 90,000 to 110,000 lbs. on each neck or journal. Bearing temperatures often reach 300 deg. F. due to friction resulting from a differential in speed of the rolls, which is usually 3 to 1.

The process has been successfully applied to 60 and 84-in. mill rolls, various refiner rolls, mixing, crusher, washer, and tin mill rolls, Gordan plasticator screws, hard rubber grinding rolls, and warming mill rolls.

Liquid Soldering Flux

"Special X" is the trade name of a new liquid soldering flux particularly intended for "difficult to solder applications", says the Industrial Service Laboratories, 915 W. Oklahoma Ave., Milwaukee. It is the result of two years' intensive research on soldering fluxes. It can be used on brass, copper, cadmium, stainless steels, zinc, monel, iron, and many other alloys.

Research was particularly undertaken to provide a better flux for builders and fabricators of alloy steel and Monel equipment but results have shown that it works unusually well in production or "line" soldering of toys, expansion valves, electrical controls, small pressure tanks, restaurant equipment, milk coolers, lighting fixtures, etc.

Lowered surface tension and good wetting power or flux cause quick and uniform flow of solder into all cracks and crevices.

Manufacturer will supply working sample and technical data upon receipt of request on your company letterhead.

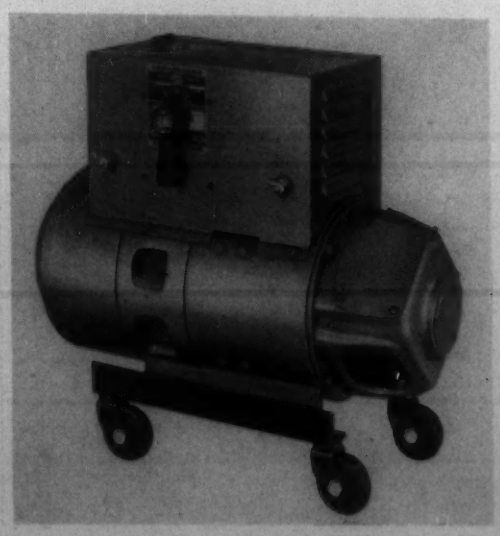
Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts no more than 2 in. wide.

A Direct Current Welder

A new direct current arc welding motor generator set, with a rating of 150 amp. at 25 volts, and having a range of adjustments from 20 to 200 amp. at 25 volts, has just been announced by Wilson Welder and Metals Co., Inc., New York City. Current control on this new welder consists of a 3-point current switch and a dial rheostat control for fine adjustment. It is stated that the smoothness and precision of this adjustment makes it possible always to get the right current, and greatly enhances the adaptability of the machine to all types of electrodes, from bare to heavily coated. Open circuit voltage is from 40 to 75 volts. The set will use electrodes up to 3/16-in. diameter. Standard wiring is for 3-phase, 220 or 440-volt, 60-cycle power supply.

Welding qualities claimed for this welder are a steady arc and quick voltage recovery, that it welds without current surges and without losing the arc when welding on thin sections. It is expected that these features will greatly reduce losses due to burning through, and also those due to the necessity for rewelding defects caused by arc interruptions.

The portable model, equipped with strong rubber tired casters, is 12 by 26⅜ in., stands 23⅝ in. high, weighs 338 lbs. The stationary model, without casters, weighs 8 lbs. less. The new welders are sturdily built for continuous production service, and attractively finished in yellow.



Magnesium Alloy Speeds Shipping

Industry is placing strong emphasis on the elimination of needless weight. This vital need for light-weight metals that provide strength, toughness and durability is being met by magnesium alloys. Last holiday season at the Jacksonville, Florida, terminal, with the help of this new metal alloy, the Railway Express Agency efficiently and expeditiously handled more than 2,500 carloads of express matter. Magnesium alloy was adapted to their use in the form of portable gravity conveyors, replacing the heavy steel conveyors, previously used.

The portable steel gravity conveyors, which had been used to a limited extent by the

Railway Express Agency, were limited in their usefulness due to their excessive weight. The conveyors in 10-ft. lengths had to be portable and when constructed of steel, the weight materially slackened their handling, hence did not increase shipping speed.

The theory of using some of the lighter alloys in order to get 10-ft. and 13-ft. sections which would be sufficiently light for one man to readily carry or move was developed. According to C. G. Peterson, chief engineer, several experimental sections were constructed of Dowmetal and used in service tests, the rollers, the through shafts and the 3-in. side rail with extruded channels all being made of Dowmetal. After an extended series of tests, it was proved conclusively that such development would be useful in many operations, such as loading and unloading to and from cars and street vehicles, and in sorting express matter for different destinations or consignees. To date more than a half-mile of these portable conveyors are in use.

(Continued on page MA 192)

Chart for Recording Meters

A new, permanent chart for recording meters, impervious to moisture and unaffected by atmospheric changes, is announced by the Permochart Co., Pittsburgh, manufacturers of Permochart —the "Everlasting Recording Chart". This is the chart from which each day's recordings are easily removed by use of a damp cloth and the same chart is used over and over again.

The new, patented Permochart is formed of three sheets of acetate, laminated under tremendous pressure, with the chart design printed from precision plates on an inner, opaque sheet and laminated between two sheets of smooth, transparent acetate. The bond between laminations is made so close under the newly developed method of manufacture that moisture cannot penetrate and the all-acetate construction eliminates any tendency to separate or buckle due to atmospheric changes.

The manufacturer claims that the new Permochart is the most accurate ever devised, that shrinkage and expansion is reduced to a minimum and that, even under the most extreme atmospheric conditions, this accuracy will not be materially affected.

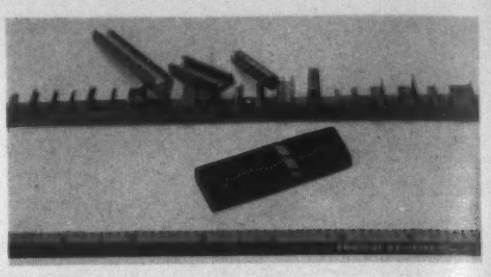
The new chart is obviously much more durable than ordinary paper charts or the original Permochart and, under normal conditions of usage, should be practically indestructible. The writing surface, though smooth and hard, is flexible. Recordings are uniform and clear. Damage due to pen penetration is entirely eliminated. Furthermore the chart does not require meter changes but is affixed and removed in the same manner as paper charts.

The Permochart Co. offers a comparison between the cost of a 2 yrs.' supply of paper charts and one Permochart (guaranteed to give 2 yrs.' service) which shows an indisputable saving of 75 to 80 per cent in favor of Permochart. Thus, if a manufacturer's recording meter chart bill reaches any proportions at all, he can immediately effect an appreciable saving without any investment beyond the cost of a 90-day supply of ordinary paper charts.

Minute Shapes in Metals and Plastics

Shapes in every conceivable design and thinness are now being made in metals and plastics for numerous industries, architects, designers, instrument-makers, inventors and other scientific workers who have long needed such precise shapes in their line of work. Because of their accuracy, these shapes are also ideally adapted to the construction of scale-true models. The new process by which these shapes are made was developed by Precision Shapes, Inc., 230 Park Ave., New York City.

"Precision Shapes," as they are termed, are of special significance in that they answer problems in design that have hitherto been impossible to achieve under the limited methods of extrusion, rolling or milling. Standard designs in brass are continuously kept in stock, but other designs, even extremely complicated in form, can be made to specification at short notice in a wide range of materials. With this new process the additional expense for dies is eliminated, with a resultant saving to the user. Another feature of this new process is



that Precision Shapes can be made in any length up to 24 ft.

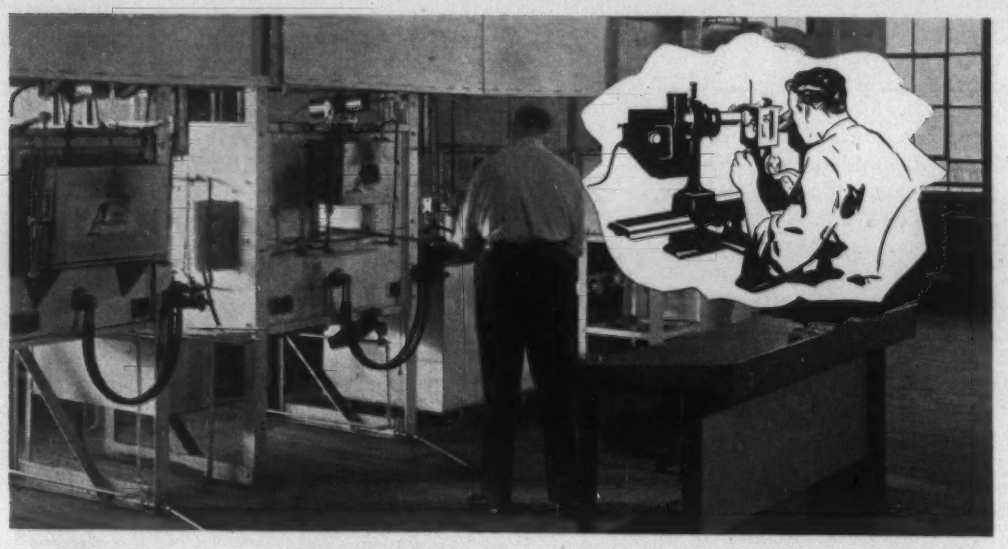
The process by which Precision Shapes are made makes possible, it is claimed, the meeting of unusual requirements in design and actually begins its work where extrusion leaves off. For instance, angles 1/32-in. with a wall thickness of 0.010-in, Tees 1/16-in. with a wall thickness of 0.012-in., channels and square channels of the same minute size, slotted angles 1/16-in. thickness, I-beams 1/16-in. with a wall thickness of 0.012-in. are among the many standard items readily available. Any conceivable shape, undercut or decorative type of strips can be speedily made to specification. There is no limit down to 0.002-in. tolerance to the design in which these shapes can be manufactured. They challenge the ingenuity of both designer and engineer, as well as the attention of production men in every line of scientific and industrial endeavor. All shapes can be slotted in any number of openings, or they may be threaded or otherwise treated to meet special structural needs.

Where only limited quantities of extruded shapes are needed, usually die costs make the price prohibitive. In such instances Precision Shapes are not only more accurate than those produced by other means, but more economical to use.

In plastics, Precision Shapes have many important uses depending on the nature of the plastic material. Internally, many different shapes are used to hold glass, metal, etc., while also acting as a reinforcement for the plastics. Externally, special decorative shapes add beauty in addition to stiffening the structure and preventing warping.

Carburizing Salts

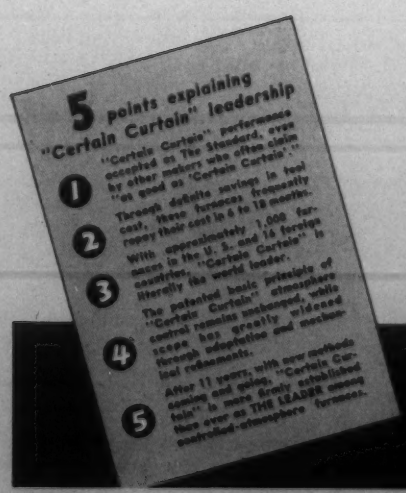
The Case-Hardening Service Co., 2281 Scranton Road, Cleveland, has folders available on request describing its new "CHS" Carburizing Salts for case-hardening. These salts are supplied in three types—No. 10 for producing a case up to 0.010 in.; No. 30, for up to 0.030 in.; and No. 70, which may be used for case depths up to 0.070 in.; or to increase the activity of either of the other two. They are intended to replace the highly poisonous cyanide baths commonly in use; and the makers claim greater stability in use, no corrosive action on the pots, no soft spots on the case, and no need for any other cleaning agent for the work except hot or cold water. It is also stated that owing to the fewer furnace-hours required for a given depth of case, and the fact that the product supplies its own heat-retaining "blanket" material, considerable heat-economy is also obtained.



"Hazards of hardening expensive tools have been eliminated."—

WELDON TOOL CO.

"Control over heat treating conditions (says Weldon Tool Co.) is maintained by microscopic inspection of hardened specimens in our modern laboratory. The 'Certain Curtain' furnaces have practically eliminated rejections after hardening. *Soft skin no longer forms; burning and blistering of fine tools are prevented; cost of cleaning and grinding is greatly reduced.* The hazards of hardening expensive tools in older types of equipment have been eliminated."



Harden high speed steels with maximum safety for maximum working life, by using "Certain Curtain", world's leading tool furnace. C. I. Hayes, Inc., Established 1905. 129 Baker Street, Providence, R. I.

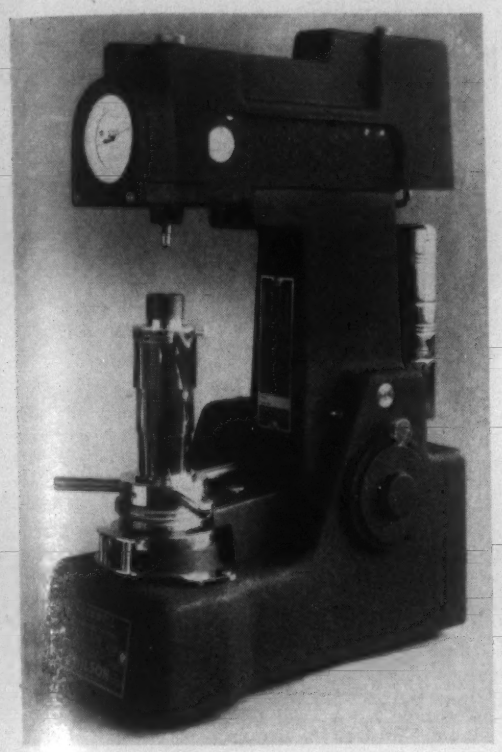
ELECTRIC CERTAIN CURTAIN FURNACES

FOR 11 YEARS THE LEADER IN CONTROLLED-ATMOSPHERE HEAT TREATMENT

Rockwell Hardness Testers QR and QS

For those whose hardness testing requirements call for 100 per cent production testing of parts made in large quantity, or for testing a large percentage of their product, the "Model QR Rockwell" hardness tester and the "Model QS Rockwell" superficial hardness tester offer many advantages without any loss of accuracy in testing.

These motorized models are made in an 8 in. vertical capacity. The readings obtained are *identical* with readings obtained on Rockwell hand-operated machines, of which many thousand are in use, and the speed has been in-



creased to a point consistent with obtaining accurate and reliable results. Specifications determined on the hand-operated models may therefore be met on these motorized testers. An extensive study of production hardness testing with light loads such as are used on the Rockwell tester indicates conclusively that speeding up the operation of the machine does not necessarily speed up in direct proportion the number of pieces that can be tested. Efficient handling of the work oftentimes can do more to increase the number of pieces tested than any amount of quickening operation of the tester itself.

The design of these motorized Rockwell testers is such that no time is wasted after the material is inserted in the machine and there is no lost time through idle cycles of machine when the specimen must be placed in position with care. Readings are absolutely independent of variations in thickness of pieces tested. There are not many applications where motorized equipment will be a decided advantage to the user, but for such applications the Q Model Rockwell and Rockwell Superficial hardness testers will give genuine Rockwell numbers on a machine which conforms to the high standards of precision and accuracy that are built into the hand-operated models. With the Q model you can test your product to the same hardness limits as previously and it is not necessary to sacrifice the quality of your inspection for the sake of making more tests per day.

A Powdered Soap for Wet Working Copper

A new powdered soap for the wet working of copper and brass known as "Nopco Soap L", has been announced by the laboratories of the National Oil Products Co., Harrison, N. J.

The new soap, described as clean, white, and free from odor, has been tested in the company's laboratory and by practical mill men in outside plants. This soap is highly concentrated, resistant to rancidity, economical, and versatile.

Nopco Soap L is recommended for use in the following wet working applications: (1) Drawing or stamping of copper and brass shells, (2) Drawing of coarse yellow brass wire, (3) Drawing of intermediate yellow brass tubes, (4) Drawing of coarse, hard bronze wires.

Colalloy—New Alloys

The Colonial Alloys Co., E. Somerset, Trenton Ave. and Martha St., Philadelphia, offers a new alloy "Colalloy." It is an alloy of manganese, magnesium, silicon, aluminum (copper and chromium where necessary), and some lesser proportions of other metals. Depending upon the use for which it is intended, it is made up in a variety of sizes, hardnesses, strengths, endurance limits and other physical and mechanical properties. For example, ultimate strength may range from 12,000 to 61,000 lb. per sq. in., yield strength from 3,900 to 4,900, Brinell hardness from 20 to 110. Melting temperature is 1,210 deg. F. and thermal conductivity at 100 deg. C. in c.g.s. units ranges from 0.27 to 0.51.

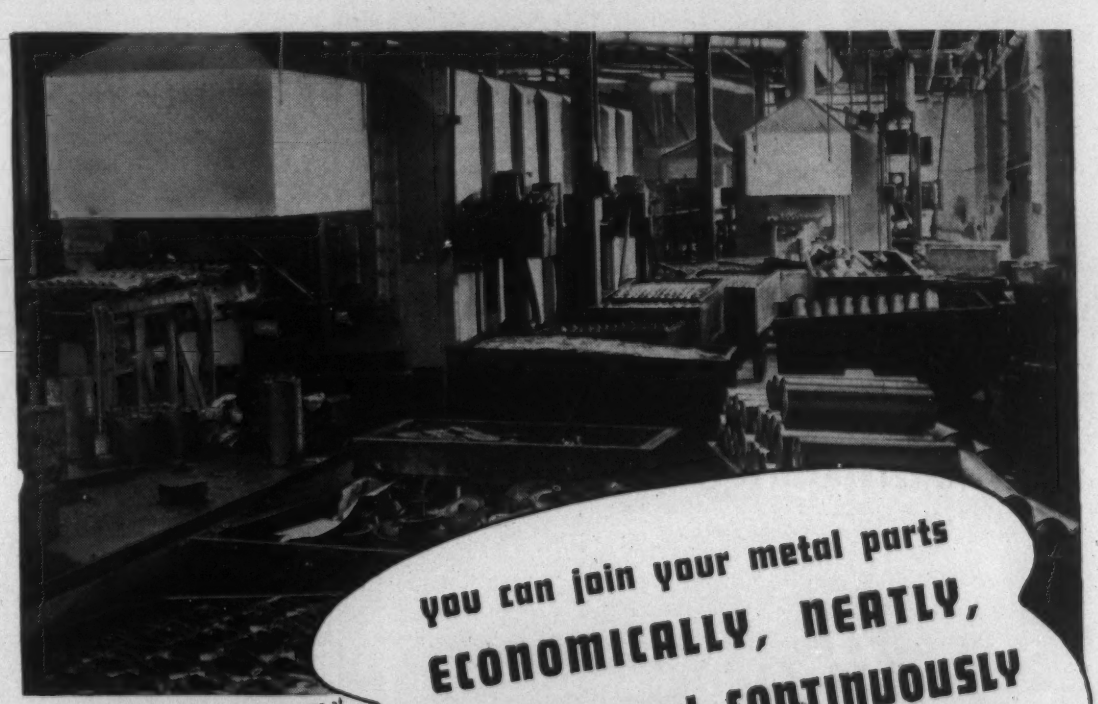
The complete range covers more than 30 alloys each suited to a particular purpose. It is claimed they will not rust, are nontoxic and have high thermal factors, and will not taint or damage the most delicate foods. Material is made in all gages, sizes and forms of sheets, strips, flats, plates, seamless tubing, fittings, structural shapes, bolts, nuts, etc.

Bronze Bearings

In another step toward meeting the requirements of industry, the Horace T. Potts Co. announces the addition of a line of bronze products to its already complete line of iron and steel products. The new line includes all sizes of standard bronze machine bearings and precision bronze bars, both solid and cored, as produced by the Bunting Brass & Bronze Co., Toledo, Ohio. This new service—which includes consultation and technical assistance—was inaugurated March 15. Stocks are now completed in the Potts warehouse, ready for immediate delivery. Literature and catalogs, giving full description and dimensions of the new bronze line, can be obtained by writing to the Horace T. Potts Co., East Erie Ave. and D St., Philadelphia.

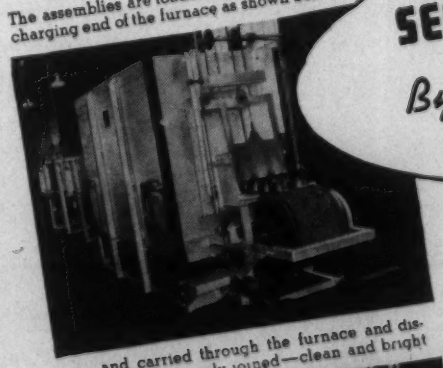
The Potts company already handles a large stock of Anaconda free-cutting brass rods as part of its complete warehouse service covering everything from machinery, stainless and structural steels to non-ferrous metals, welding accessories and home and industrial fencing.

(Continued on page MA 194)



you can join your metal parts ECONOMICALLY, NEATLY, SECURELY and CONTINUOUSLY By the ELECTRIC FURNACE BRAZING METHOD

The assemblies are loaded on a conveyor at charging end of the furnace as shown below



. . and carried through the furnace and discharged—securely joined—clean and bright

Small assemblies weighing only a fraction of an ounce as well as large intricate assemblies weighing several pounds are neatly and securely joined in numerous designs of continuous and batch type copper brazing furnaces — Built by The Electric Furnace Co., Salem, Ohio.

Four E. F. brazing furnaces are shown on this page—The two pusher type furnaces above are brazing large automotive and refrigerator assemblies. The two belt conveyor furnaces at left are brazing automobile fan pulleys. Other E. F. brazing furnaces are handling practically everything from small metal radio tube parts up to large assemblies weighing 50 pounds or more.

Send for Circular on the Brazing Process.

ELECTRIC EF FURNACES FUEL FIRED

Investigate the brazing process for your products. We will be glad to give you complete information, put samples of your products through one of these furnaces to show you the results you can expect, and give you an estimate on the cost of the equipment to handle your production, together with operating cost, etc.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

An Indicating Gage

Designed for use where endurance as well as accuracy is a prime factor, an indicating gage with an all-welded steel construction has just been introduced by The Foxboro Co., Foxboro, Mass. The all-ferrous construction of the "Model P" gage affords perfect protection on applications where there are fumes or vapors corrosive to bronze. The absence of solder and bronze eliminates the risk of fire hazard.

A special Chapmanized steel of high Brinell rating is employed in the pinion, segment, arbor and connecting link of the new Model P. To eliminate binding or raggedness in pointer motion and to insure a smoothly-operating movement, the segments and pinions used in these Foxboro gages are not blanked in, but instead have milled teeth. The movement plates, columns, links and shoulder screws are made of stainless steel.

Threaded rings, equipped with gaskets, make the Model P gage completely moisture-proof and vapor-proof and also serve to retain the extra-heavy glass firmly in place. All pointers and dials are of stainless to prevent corrosion and discoloration.

The 270 deg. bourdon spring incorporated in this gage makes possible the use of springs double the range of the gage without increasing the movement multiplication or decreasing the accuracy. Chrome-molybdenum steel is used for ranges up to and including 1,000 lbs.; above that, nickel steel tubing is used.

The Model P test gage, available in ranges from 0-15 lbs. to 0-10,000 lbs., is guaranteed accurate within ½ of 1% at any point on the range. The Model P refinery gage, furnished in ranges from 0-60 lbs. to 0-2,000 lbs., and the Model P hydraulic gage, with ranges from 0-600 to 0-10,000 lbs., are guaranteed within 1% of their total range. Further information about this new Model P indicating gage may be obtained by writing to The Foxboro Co., Foxboro, Mass.

Control that CASE DEPTH with efficient–economical

Du Pont CASE HARDENING Salts

Shallow or deep cases . . . you can obtain the right case hardening salt from du Pont to meet your individual requirements.

These salts are uniform with a guaranteed cyanide content. They provide a wide operating range and the utmost in economy.

Plan to visit the du Pont exhibits at the GOLDEN GATE INTERNATIONAL EXPOSITION in San Francisco and at the NEW YORK WORLD'S FAIR

?

LIQUID BATH PROBLEMS

Tell us about them. Our research and field staff will gladly help you find the answer.

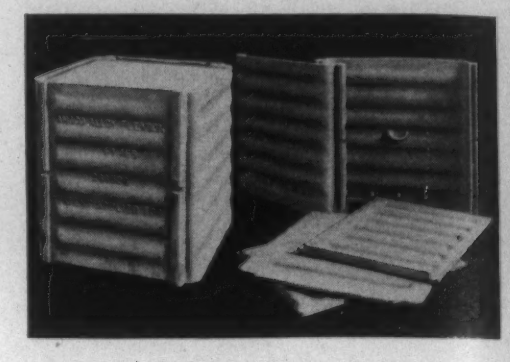
DU PONT

E. I. DU PONT DE NEMOURS & COMPANY, INC.
The R. & H. Chemicals Department
Wilmington, Delaware

District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

Sectionalized Heat Treating Boxes

U. S. Patent No. 2,144,374, issued Jan. 17, 1939, to Walter G. Hoffman and assigned to The American Brake Shoe & Foundry Co., covers the device shown which is manufactured by the American Manganese Steel Division, Chicago, Heights, Ill. Annealing, carburizing and heat-treating boxes suffer rather brutal treatment generally; and, in particular, from high furnace temperatures, variable temperatures during the heating cycle, and differential heating. They are bound to burn out, crack or break, sooner or later, but the Flexbox design is calculated to make this "later." "Flexboxes" are made of Amsco alloy, in the grade best adapted to the particular requirements.



The ends, sides, bottoms and covers are cast separately. The ends are made with vertical grooves into which fit corresponding tongues on the side castings. There are matched slots in both tongue and groove for holding pins to prevent relative vertical movement of the parts, but this does not hinder adequate horizontal movement. Distortion or cracking, resulting from alternate heating and cooling, is avoided in the Flexbox by providing sufficient clearance between tongue and groove to allow for expansion and contraction. Corrugations in the castings are said to give greater strength under high temperatures. Light cast covers, corrugated or flat, with or without legs, are used to replace the old style bottoms cast integral with the boxes. Special bottoms in which the edges fit into grooves in the lower edges of the end plates are available where the complete box with its contents is to be lifted.

The features of the Flexbox are: 1. They mechanically avoid the stresses set up by contraction and expansion resulting from rapid heating and cooling, but do not allow any appreciable gas leakage at the vertical joints. 2. Thinner and sounder castings result from this design as each section is a simple casting, much smaller than a one-piece box. 3. Should a section of the box fail, it is easily and quickly replaced at a fraction of the cost of replacing an entire box. 4. As in the case of all Amsco alloy parts, X-rays of check castings minimize the possibility of placing defective castings in service.

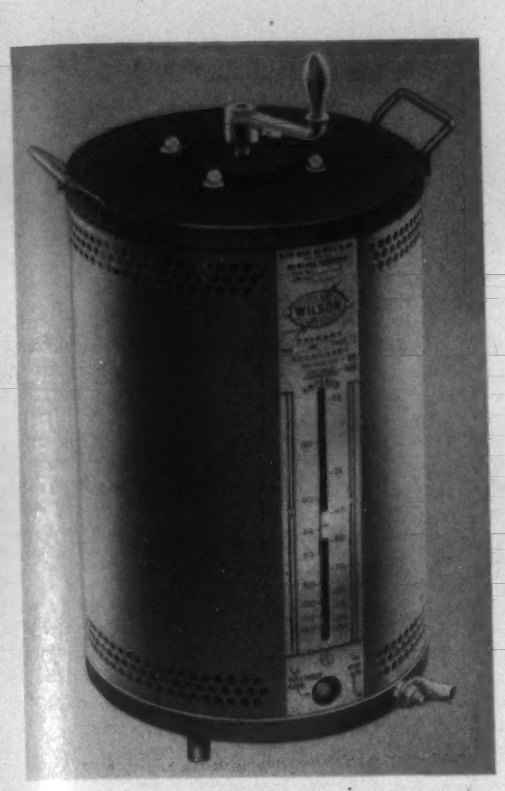
Vibration-Proof Indicator Pyrometer Controller

A vibration-proof "Celectray Indicating Potentiometer," Celectray Model V, has been developed. Photoelectric detection of the position of a light-beam reflected from the mirror of a moving galvanometer provides an undiminished high sensitivity of the original Celectray Indicating Controller combined with practically instantaneous response. A new damped photoelectric circuit has been developed which does not respond to abnormal disturbance of the light-beam. So far as vibration is concerned Celectray Model V acts somewhat as a filter, that is, the action of vibration upon the galvanometer cannot effectively be transmitted through the instrument to the control device such as a magnetic contactor. This controller can be mounted rigidly in a vibrating panel along with the contactor or next to a drop hammer without regard for the possible effect of vibration. Vibration does not even cause the primary relay within the instrument to operate nor does it interfere with normal action of the controller. It is claimed that the instrument is sensitive to temperature change but not to vibration. All the advantages of the previous successful Celectray models have been retained such as the safety shut-off feature, 15-in scale, 0.1% accuracy and indications by a brilliant white, red or green line of light on ground-glass, visible at a great distance.

Arc Welder For Light Gage Sheet

The Wilson Welder and Metals Co., Inc., New York City, announces a new arc welder of 100 amp. rating at 30 volts for light sheet metal welding and other light work requiring low current and fine control. The new machine is of the alternating current, transformer type, and designed especially for use with heavily coated electrodes. Standard wiring is for single phase, 220-volt, 60-cycle power supply, but it can be furnished for 440-volt supply if desired. Open circuit voltage is 65 volts.

A calibrated scale on the front of this welder indicates the adjustment throughout the range of the machine, which is from 25 to 150 amperes. This adjustment is made continuously by rotating a crank at the top, and



because the circuit is not broken there is no need to stop operations and open any connections while a change is being made. The continuous nature of the adjustments makes it possible to tune the current exactly to suit the thickness and welding characteristics of the material being welded and of the electrode used.

Alternating current welders of this size have been found to give the best performance when electrodes made especially for A.C. welding are used. Therefore the company recommends Wilson No. 520 with this model. It will accommodate diameters up to 5/32-inch.

Enclosed in a sheet metal housing 16½ in. in diameter and 24 in. high, weighing 145 lbs., the new welder is a compact and mobile unit. The whole construction has been designed to the complete safety and durability required in production welding departments. The welder meets the requirements of the latest standards of the Underwriters' Laboratories, Inc.

Thor Core Binder

A newly patented process, whereby milk solids are used as a binder for the sand cores of foundry castings, has resulted from several years' operation of a research fellowship by The Borden Co., New York, at Mellon Institute, Pittsburgh. The product, called "Thor Core Binder," is now being produced commercially by Casein Co. of America, division of the Borden company. It is used in both core and facing sands. The binder has the feature of burning freely and quietly. This contributes toward a smoother surface on the casting, and produces a core which is quickly and easily shaken out. Thor cores are hard and strong, and yet very collapsible under heat of the casting. Several important manufacturers have made quantity use of this process over a period of years, and it is now considered to be entirely practical and ready for general use.

Chemically Treated Buffs

An interesting method of making buffs last longer and stand up better against abrasive wear is a chemical treatment perfected by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies. These buffs are made of two types of square count cloth called Economy and Tractor. The buffing cloths, as they come from the loom, are passed through a chemical bath. The wear resistance developed by this chemical treatment is further increased by the carefully balanced construction of the buffing textile. It is stated also that the treated buffs absorb polishing composition better, giving improved cutting and coloring action on the product being buffed.

The chemicals used for treating the buffs include a hygroscopic element whose purpose is to absorb moisture from the air, fixing it in the cloth and giving a conditioned sheeting at all times.

Improved Trimming Machine

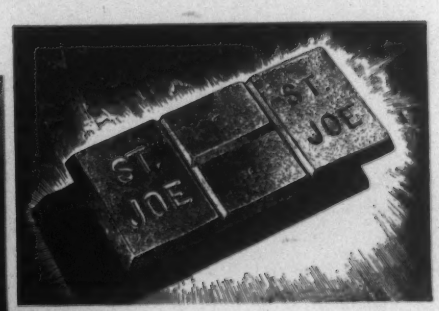
In the early part of last year the Quickwork Co., Chicago, announced a new stamping trimming machine, (May, 1938, MA332). Important improvements have been made on this machine. It is arranged now to operate the machine with an electric eye.

In the previous design the operator actuated the pneumatic air cylinder which opened and closed the rolls with a foot pedal control. In the present design, this is done by means of a photoelectric-relay. This has proved very convenient and has resulted in increased production. After the operator loads the machine, he moves his right hand horizontally through the beam—this permits the operator to stand firmly on both feet at all times. The electrical equipment to accomplish this is not involved and is easily housed within the base of the machine. The arm carrying the electric eye can be swung away from the table and rolls if convenient in changing setups.

(Continued on page MA 196)

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 2 of a Series



Man-made Caverns

"Underground photograph of a stope in the Balmat Mine of the St. Joseph Lead Company in St. Lawrence County, New York State."

The limestone is so solid that no timbering is necessary. The veins have a dip of about 45 degrees. Distance from foot wall to hanging wall at places, is over 60 feet, and the man-made caverns left after blasting out 400,000 tons of rock a year grow to gigantic dimensions. From these stopes the zinc in the ore starts its long journey, traveling by gravity to the underground chutes and ore pockets, eventually being converted into St. Joe electro-thermic zinc at the Josephtown, Pennsylvania, smelter of the St. Joseph Lead Company.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE • NEW YORK
ELdorado 5-3200

PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Pressure Fan

Outstanding feature of the Sturtevant "Axiflo Pressure Fan" is the ability to operate against wind resistance or the resistance of filters, baffles, discharge conduits etc. Blades are so pitched that regardless of wind direction or velocity or fan location, there is no appreciable effect on air delivery.

Principal use of the Axiflo Pressure Fan is the moving of large volumes of air against resistance, or where space requirements call for a rugged yet highly compact unit. The ease with which it may be installed, and the comparatively low initial and operating cost makes it well adapted for almost any industrial application, including heating, ventilating, cooling, mechanical draft, drying, humidifying and fume, vapor or dust removal.

The Axiflo Pressure Fan has a mechanical efficiency of 79% and the ability to overcome system resistance up to 1½ in. w. g. It possesses the economical operation advantages of the axial flow type of fan combined with the performance of the centrifugal fan. Unlike the ordinary propeller fan, the Axiflo Pressure Fan is ruggedly constructed. Casing is heavily built and fitted with streamline inlet. Wheel is of solid and integrally cast heat-treated aluminum alloy which is non-corrosive under the action of most acid content chemical fumes. The Axiflo Pressure Fan is available either for direct connected motor drive or for belt drive, and arranged for wall, floor, platform or ceiling installation. Eleven sizes are available, ranging from 18 to 60 in. diameter with capacities up to 75,000 cu. ft. per min.

For complete details including capacity tables, corrosion resistance tables and dimension diagrams write for catalog 444, B. F. Sturtevant Co., Hyde Park, Mass.

Special High Grade ZINC

Guaranteed 99.99+% Pure

WHEN you choose Anaconda Electric for the base of Zinc die castings, you are certain of obtaining uniform, dependable metal. For every slab of Anaconda Electric Zinc is electrolytically refined and guaranteed 99.99+% pure.

Anaconda Electric Zinc is supplied in 50 lb. slabs clearly marked "Anaconda Electric 99.99+%." Whenever you use this well-known brand, whether in small quantities or carload lots, you may be sure that *every slab is uniform in quality... is by analysis 99.99+% pure.* 39892

Shipping Point: Great Falls or Anaconda, Montana

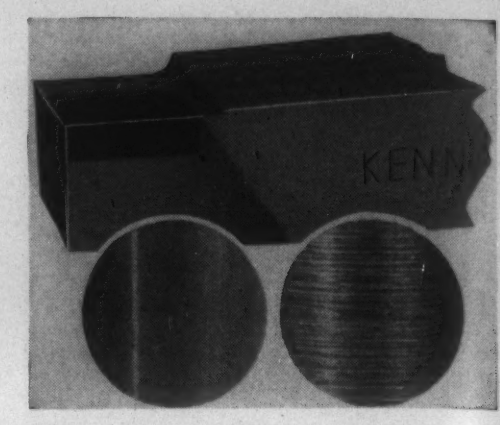
ANACONDA from mine to consumer

ANACONDA SALES COMPANY
25 Broadway, New York
Subsidiary of Anaconda Copper Mining Company

"Kennametal"

A new, reliable, hard carbide alloy for machining tough metals such as steel, heat treated up to 500 Brinell, which combines roughing and finishing in one operation, is now being supplied under the trade name of "Kennametal" by the McKenna Metals Co., 158 Lloyd Ave., Latrobe, Pa. The basic ingredient is tungsten-titanium carbide ($WTiC_2$) and the new alloy may also be used in machining Monel metal, malleable iron, cast iron, brass, bronze, aluminum, etc.

Kennametal is available in three standard styles of blanks from which tools may be tipped

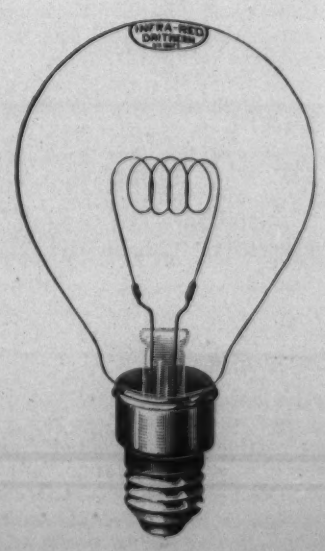


by the user, or it may be purchased in other than standard blanks. The manufacturer also offers an assortment of 18 styles of Kennametal tipped tools for operations such as reaming, boring, tapping, milling, gaging, etc. The illustration shows Style No. 11 tool, tipped with Kennametal, and the unretouched inserts show the smooth finish of Kennametal form-tooled bar stock (magnified three times) as compared with surface machined with high speed steel, or tungsten carbide.

Kennametal permits 2 to 6 times greater cutting speeds than those of high speed steel and 10 to 50 times as many pieces per grind of tool. It is harder than the hardest tool steel. The manufacturer has prepared a new, descriptive booklet and will be glad to furnish complete information on request.

Infra-Red Ray Lamps for Radiant Drying and Heating

Dritherm is the name under which the newly improved "Nalco Infra-Red Ray Lamp" will be marketed. These lamps, made by the North American Electric Lamp Co., Saint Louis, have been especially manufactured for radiant drying and heating purposes. They represent the final development of over 4 years' research and practical application in a number of the country's largest plants, including automobile plants, where they are used for paint baking.



Long burning life in proportion to high efficiencies obtained, uniformity of filament materials, as well as placement of carbon filament within the bulb, and rugged construction to minimize breakage—are several features claimed for these lamps.

Full details, sizes, prices, etc., as well as material on the application of radiant drying and heating installations may be obtained by writing North American Electric Lamp Co., 1014 Tyler St., Saint Louis, Mo.

Current Metallurgical Abstracts

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APRIL, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

1·ORE CONCENTRATION

Crushing, Grinding, Plant Handling, Gravity Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

JOHN ATTWOOD, SECTION EDITOR

Classified Grinding Research. LEONARD ANDREWS. *Bull. Inst. Mining Met.* No. 409, Oct. 1938, 25 pp. Standard units of measurement necessary for free interchange of results of grinding research between countries are proposed. The rise of temperature in a wet grinding mill is due mainly to 2 causes: (1) Molecular stretching and shearing of the strained suspending medium surrounding the solid particles and (2) molecular agitation in particles not fractured by blows received. There is an appreciable reduction of shear resistance with increase of temperature—40% over 10° F. for one pulp. At constant temperature, shearing losses are directly proportional to interfacial surface area of the pulp. Pulp density has little effect on shear resistance other than an indirect contribution to the interfacial surface area. Tests on a commercial batch pan mill grinding pottery flint confirmed these laboratory findings. High-velocity directional streams are generated in classifiers by the momentum of the incoming feed. This can be entirely avoided through the use of the vortex diffuser feed, which is described. Air bubbles in classifier feed carry over particles much larger than theoretical; their effect can be nullified by use of submerged intakes to classifier overflow discharge pipes. Aggregates can be dis-associated by a water vortex a few inches above a sand surface. Accurate elutriation of particles above 100 μ can be accomplished using this principle. The best working head for discharge of sand from classifiers is 2-9 in. of H_2O. At less than 1 in., velocity of discharge is so reduced as to destroy fluidity; at more than 10 in., coring is liable to occur. Since normal head on a spigot discharge from a cone classifier is 6-10 ft., the top should be closed and the normal head balanced by a syphon overflow pipe (drawings given). AHE (1)

Gold Concentrates Defy Cyanidation. J. G. HART. *Chem. Eng. Mining Rev.,* Vol. 31, Oct. 1938, pp. 9-11. A study was made to determine whether concentrates at the Maude and Yellow Girl Mine at Glen Wills, Vic., could be treated at the mines to avoid heavy freight costs. It was found that (1) only part of the Au in the concentrates is available to amalgamation and cyanidation methods. A maximum recovery of about 54% of the Au was obtained by straking and cyanidation at —200 mesh with a cyanide consumption of 5.6 lbs./ton. (2) The lowest residue value obtained in laboratory experiments was 32 dwt. Au/ton by cyanidation at —10 micron. (3) Roasting followed by regrinding to —200 mesh, straking and cyanidation resulted in 56% extraction of the Au, the final residue value being the equivalent of the straight cyanidation residue. (4) A relatively large amount of sub-microscopic or unrecognizable Au was present in the arsenopyrite and pyrite of the cyanidation residues. Only complete disruption of the particles by chemical means can lead to complete extraction of the Au. WHB (1)

Metallurgical Developments at Mercur, Utah. W. J. FRANKLIN & VIRGIL MILLER. *U. S. Bur. Mines Tech. Paper* 588, 1938, 42 pp. Descriptive. The Au in the oxidized ores is readily soluble in cyanide solutions and is treated in a continuous countercurrent decantation cyanide plant. The Au in the basic ores is not amenable to straight cyanidation, owing to the presence of C, cyanicides and soluble salts. Good extraction was obtained in the laboratory by roasting followed by cyanidation; mill tests were unsatisfactory owing to high costs and inability to treat the calcine which formed a gel in the thickeners. The ores can be treated by a flotation-cyanidation process. A Au concentrate is made containing some cyanicides and the C in the ores. The tailings can be washed free of soluble salts and then treated in the regular cyanide circuit. Costs are considerably less than by any other known method. The tailing dumps can be treated by the same methods. AHE (1)

Read "TRENDS" . . .

on page MA250 for the latest news, its significance, and what it means to metallurgical engineering, as seen by E. F. Cone.

Research on the Influence of Preliminary Treatment on the Flotation of Bituminous German Copper Ore of the Mansfeld and Niedermarsberg Type (Untersuchung über den Einfluss einer Vorbehandlung auf die Schwimmfähigkeit bituminöser deutscher Kupfererze vom Typ Mansfeld und Niedermarsberg) H. MEFFERT. *Metall u. Erz,* Vol. 35, No. 3, 1938, pp. 55-58. Research. Flotation tests were made on carbonaceous shales containing small amounts of Cu. The Mansfeld type contains about 84% gangue, 7% carbonaceous matter and about 9% metallic sulfides with a Cu content of about 3%. Pb and Zn sulfides are also present. Niedermarsberg ores contain greater amounts of quartz and pyrite and smaller amounts of Cu and carbonaceous matter, otherwise the ores are much alike. The Niedermarsberg ore, in spite of the presence of the carbonaceous matter, can be floated to a concentrate of 20% Cu without any preliminary concentration. Mansfeld ores produce a thick and voluminous froth that entraps gangue material and prevents a concentration of over 10% Cu in spite of numerous supplementary treatments. The reason for this behavior is attributed not so much to the carbonaceous matter or the surface properties of the ore but to the manner of reduction. From the evidence of the concentrate and tailings, which indicate very fine particles in the tailings and larger grains in the concentrate, it appears that the Mansfeld ore is ground too fine in the ball mill for satisfactory flotation and grinding to a minimum of about 15μ is recommended. Dry grinding probably can be most advantageously employed. The correctness of these conclusions must be verified by further work. PCR (1)

Use of an Alternating Pressure Field in the Wet Preparation of Ores (Anwendung eines Druckwechselfeldes in der Nassaufbereitung) HELMUT KRAINER. *Metall u. Erz,* Vol. 35, No. 18, 1938, pp. 471-474. Research. After a short discussion of the theoretical and experimental fundamentals and the physical properties of ultra sound waves in liquids, called "alternating pressure field," a study of a dusty, high SiO_2, Fe-Mn ore was made that previously could not be separated by known means. By exposure to the high frequency sound waves followed by gravity separation, the ore can be separated into Fe containing quartz grains and a clayey, fine-grained material that consists mostly of metal hydroxides. Mn and Fe recovery is 96.5 and 85%, respectively. PCR (1)

The Getchell Mine—New Gold Producer of Nevada. ROY A. HARDY. *Eng. Mining J.,* Vol. 139, Nov. 1938, pp. 29-31. The Getchell mine in Humboldt Co., Nev., is now cyaniding 500 tons of oxidized and W-bearing ore and 150 tons of sulphides daily, with preliminary roasting for the latter ore. A flowsheet of the 600 ton mill is shown. The oxidized ore can be cyanided directly, whereas 50% of the Au in the sulphides is refractory and cannot be cyanided. All sulphide ores are given a low-temperature roast of 1500° F. for 1 hr. and 15 min. prior to cyanidation. WHB (1)

The Condition of Refractory Gold in Lake View and Star (Kalgoorlie) Ore. N. I. HASZARD. *Proc. Australasian Inst. Mining Met.,* No. 108, Dec. 31, 1937, pp. 253-324. Descriptive. Au in flotation concentrates occurs free, as tellurides and associated with pyrite (20-30% of heads). The last is refractory, is not freed even at 5 microns, and causes high losses in the residue. The free Au and tellurides are dissolved readily by cyanidation or bromo-cyanidation. A quick roast at high temperatures adversely affected extraction. A low temperature roast finished at high temperatures gave good results. Extraction was improved by acid treatment of the concentrate or by treating clean pyrite; the interfering substance seems to be $CaCO_3$. AHE (1)

Electrostatic Separation. III. The Process, Recently Improved, Now Invites Wider Application. HERBERT BANKS JOHNSON (Ritter Prod. Corp.) *Eng. Mining J.,* Vol. 139, Dec. 1938, pp. 41-45. The possibility of reversal of polarity of the electrostatic charge on many of the common economic minerals facilitates their separation. Improvements of the Huff process of electrostatic separation involving reversal of polarity are noted, also the results of such separation on a number of minerals. Estimated costs are given for a representative example. WHB (1)

2·REDUCTION

Blast Furnace Practice, Smelting and Electro-refining.

2a. Ferrous

Microscopic Investigation of Krivoi Rog Sinter. YA. GRECHNI. *Teoria i Pract. Met.*, No. 7-8, 1938, pp. 23-31. In Russian. Research. The petrographic structure of sinter made under different conditions was determined. The magnetite-fayalite eutectic was observed in all samples, though in different crystalline forms; the relation between magnetite and fayalite varied within wide limits, not only because of supercooling, but because the magnetite present was precipitated from the solid solution of magnetite and fayalite. Ferrous oxide does not exist here as an independent component and is replaced by a wüstite-fayalite eutectic. A small amount of hematite-fayalite eutectic was frequently observed, principally in place of the secondary hematite. This suggests that hematite in eutectic mixtures is of a secondary origin. No quartz-fayalite eutectic was found, even after long heating. The finely divided matrix in which fayalite-magnetite crystals are imbedded appears to be a triple eutectic SiO_2-Fe_2SiO_4-Fe_3O_4. No FeO-Fe_3O_4-Fe_2SiO_4 eutectic was found. An intergrowth of hematite along the octahedra planes was very pronounced, and can be explained by the decomposition of hematite-magnetite solid solution. The coefficient of refraction of the fayalite varied between 1.82 and 1.92 (1.877 for pure fayalite). This can be attributed to the presence of solid solutions with ferrous oxide and magnetite. (2a)

Blast Furnace Instrumentation. F. N. HAYS & L. P. MIKALOFF (Carnegie-Illinois Steel Co.) *Instruments*, Vol. 11, Dec. 1938, pp. 297-300. Survey. The following instrument applications essential to regular and economic operation of a modern blast furnace are discussed at length: (1) Blast temperature, (2) automatic hot blast temperature control, (3) automatic combustion control for stove burners, (4) stove stack temperature, (5) stove dome temperature, (6) stock line recorder, (7) top temperature, (8) blast pressure, (9) blast volume and (10) humidity and atmospheric pressure. The moisture carried into a 1000-ton furnace with the blast may vary from 72 gals./hr. in the winter to 1100 gals./hr. in the summer. The value of the fuel gas leaving the top of a 1000-ton furnace is approximately $400,000 per annum. Air-conditioning of the blast may save 10% C, increase the furnace production and improve its regularity. Determination of the dust content of the top or fuel gas by light transmission or photo-electric principles, automatic flow proportioner, continuous determination of CO and CO_2, or of their ratio, determination of the Fe and slag temperatures are still in their infancy. EF (2a)

Study of Hot Stoves Used with a Standard Blast Furnace. S. DROBYSHEVSKI. *Teoria i Pract. Met.*, No. 7-8, 1938, pp. 6-11. In Russian. A detailed study covering 20-day operation of a 2-pass 3-zone hot stove was used as a basis for calculating its thermal efficiency. The stove was kept on gas until its dome temperature reached 1200° C., and on air until the temperature dropped to 750° C. The greatest losses are connected with surface radiation, particularly around the combustion shaft and on the dome. Better insulation is advocated for reducing these losses by 20-25%. An improvement in thermal efficiency can be expected when the free cross-section of the checker work in multizone stoves is always reduced on passing from the upper to the lower zone. (2a)

2b. Non-Ferrous

Recovery of Precious Metals and Production of Selenium and Tellurium at Montreal East. C. W. CLARK & J. H. SCHLOEN (Canadian Copper Refiners, Ltd.) *Metals Tech.*, Vol. 5, Oct. 1938, T.P. No. 982, 22 pp. Descriptive. Blister cakes from Hudson Bay Mining & Smelting Co., Flin Flon, Manitoba, and commercial anodes from Noranda Mines, Ltd., Noranda, Quebec, are refined at Montreal East. Both of these bullions have unusually high Au, Se and Te contents. The average assay of raw slimes produced from domestic and Noranda anodes is about Cu 40%, Ag 3600 oz./ton, Au, 800 oz./ton, Se 22% and Te 3.7%. A Ag refinery, and methods used for recovering Se and Te, are described in detail. JLG (2b)

Cathodic Polarization During Electrolysis of Molten Salts. S. A. PLETNEV & V. N. ROSOV. *Zhur. fiz. khim.*, Vol. 11, May 1938, pp. 641-645. In Russian. Original research. Preliminary measurements of the polarization during electrolysis of molten $PbCl_2$, using a cathode of liquid Pb, or of solid C, are described in detail. The measured potential is the sum of a relatively small polarization voltage and a much greater voltage of purely ohmic character. With a C cathode, the potential varied depending on the direction of the change of current density. For the principal measurements an oscillograph permitting the polarization voltage and ohmic voltage to be measured separately, was used. Pure molten $PbCl_2$ or a eutectic mixture of KCl and LiCl with various amounts of $PbCl_2$ or $CdCl_2$, were used as electrolytes. The polarization as depending on current density and the $PbCl_2$ or $CdCl_2$ content of the molten mixtures, at 500° C., were determined. The deposition of Pb from pure molten $PbCl_2$ took place at the equilibrium potential, in contradiction to the findings of Karpachev & Poltotoralskaya (*Zhur. fiz. khimii*, Vol. 6, 1935, p. 966) and Karpachev & Rempel (*Zhur. fiz. khimii*, Vol. 8, 1936, p. 134), which are ascribed to their incorrect experimental procedure. In the mixed electrolytes, the polarization increased but very little with the current density, and decreased with increasing $PbCl_2$ or $CdCl_2$ content. The cathodic polarization was perceptible at 0.6 and 1.5 mol. % $PbCl_2$, but was absent at 8 and 16 mol. % $PbCl_2$; whereas it attained 20 millivolts at 1 mol. % $CdCl_2$ (thus being about 3 times greater than at 1 mol. % $PbCl_2$) and was still measurable (5 to 2 millivolts) at 23 to 47 mol. % $CdCl_2$. The results indicate that, in the case of $PbCl_2$ mixtures, the cathodic polarization is of the concentration type, *i.e.*, it is caused by a deficiency of Pb ions on the cathode owing to their insufficiently great rate of diffusion; whereas, in the case of $CdCl_2$ mixtures, it is probably caused by an insufficiently great rate of dissociation of the complexes present in the molten mixture. ORS (2b)

Effect of Solution Concentration in Electrodeposition of Manganese. S. M. SHELTON & M. B. ROYER (Bur. Mines) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 33, 12 pp. Original research. A small pilot plant was operated to study the production of electrolytic Mn from ores. MnO_2 ores were reduced by city gas to Mn^{++}, leached with dilute H_2SO_4 + $(NH_4)_2SO_4$ solution and the resulting solution purified by removing Fe, As, Co and Ni. Pb anodes and 17% Cr steel cathodes were used, with canvas separation diaphragms. The fresh solution fed to the cathode compartment during operation contained 25 g./l. of Mn; pH, 7.2-7.6. The Mn content of the catholyte was 10 g./l., and pH 9.0-9.2. The anolyte contained 3-6 g./l. of Mn and 25-35 g./l. of H_2SO_4. The cathode current efficiency was about 50%. Power used was 3.6 kw.-hr. per lb. of Mn produced. The voltage-current density relationships of baths with varying Mn content of the feed solution and $(NH_4)_2SO_4$ content of the bath, were studied to determine the most economically desirable bath. The mutual solubilities of $MnSO_4$ and $(NH_4)_2SO_4$, are limited and too concentrated a solution must be avoided to prevent crystallization. A high Mn content of the feed solution results finally in a high acid content of the anolyte, which increases the conductivity of the cell. With a feed solution of 40 g./l. Mn, and current density below 3 amp./dm.^{2}, increase in $(NH_4)_2SO_4$ concentration above 125 g./l. does not materially increase the cell conductivity. AB (2b)

Influence of Coke, Temperature and Time on the Reduction of Zinc Oxide (Einfluss von Koksart, Temperatur und Zeit auf die Reduktion von Zinkoxyd) C. F. BRENTHEL & I. A. LEROUX. *Metall u. Erz*, Vol. 35, No. 7, 1938, pp. 173-174. Research. At 1000° C., reduction was 81.5 and 97.0% complete after 1 and 3 hrs., respectively, using lignite coke, and 41.5 and 48.5% using coal coke. At 950° C. recovery was only 72.1% after 3 hrs. and 98.5% at 1100° C. using lignite coke. PCR (2b)

Copper-smelting Plant Remodeled for Direct Smelting. LEONARD LARSON (Nev. Consolidated Copper Corp.) *Metals Tech.*, Vol. 5, Oct. 1938, T.P. No. 981, 11 pp. Descriptive. In 1932 the Cu smelter at McGill, Nev. was remodeled to send a charge of wet flotation concentrates to the reverberatory. The procedure of using the raw concentrate instead of roasted material proved satisfactory. The present plant is described in some detail. A matte containing approximately 30% Cu is produced. JLG (2b)

3·MELTING, REFINING AND CASTING

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Preparation of Pure Metals (Die Darstellung reiner Metalle) CECIL H. DESCH. *Vorträge der Hauptversammlung 1938 der Deutschen Gesellschaft für Metallkunde, V.D.I. Verlag, Berlin,* 1938, pp. 1-5. Original research plus review. The difference between Al of extreme purity and slightly contaminated Al is remarkable. In the light of atomic distribution, the effect of impurities is difficult to explain. Because of surface tension, the dissolved element must be present in a different (mostly higher) ratio at the grain boundaries than in the rest of the mass. Highly pure Al, like Pb, recovers from cold work at room temperature. Al can be produced in a purer state on a large scale than in the laboratory. Spectroscopically pure Zn of 99.995% and Pb of 99.999% purity are available. Electrodeposition has been abandoned in favor of chemical preparation for Fe. After powder-metallurgical conversion, this high purity Fe has a Brinell hardness of 42, contains about .002% Si, .0015% S, .001% P, .0006% Ni and spectroscopic traces of Cu, Cr, Al, B, Ca and Mn. The latest determinations yielded .00045% C and .0005% O. Remelted electrolytic Cr is, in spite of traces of O, spectroscopically pure; its melting point is 1830° C. Absorption of N causes the hardness to increase drastically, and the melting point drops to 1580° C. at the eutectic point. Purest, brittle, metallic bright Mn is obtained by distillation and analyzes 0-0.004% Si, 0.003% Fe, 0-0.001% P; its melting point is 1247° C. Si is purified by chemical means and contains 0.02% Fe, 0.02% Al, 0.009% Ca, 0.006% insolubles. Pure Ni and Co are obtained by reduction of their oxides with C or H. Further distillation of purified Ni carbonyl is also applied. Further progress on the preparation of pure Mo and W along powder metallurgical lines is reported, and an automatic recording equipment for thermal analysis and melting point determinations is described. EF (3)

New Resistance Melting Furnaces with Graphite Rod Heater Units (Neue Widerstands-Schmelzöfen mit Graphitstabbeheizung) OTTO GENGENBACH. *Vorträge der Hauptversammlung 1938 der Deutschen Gesellschaft für Metallkunde, V.D.I. Verlag, Berlin,* 1938, pp. 97-98. Descriptive. A tilting drum furnace is provided with a graphite resistor rod located at its axis. A current of several thousand amps. is employed to heat the graphite rod to about 2,000° C. The terminals are water-cooled and at one end suspended freely to permit expansion. Up to 100 kw., the furnaces are single phase. The graphite rod burns up slowly and its diameter is reduced to half its original size after 6-8 melts of steel cast at 1650° C. However, in comparison with the arc furnace, the graphite rod consumption is only about 1/5, owing to the neutral furnace atmosphere. About 800-1000 kw.-hrs./ton and 250-300 kw.-hrs./ton respectively, for steel and bronze are consumed. Chips and scrap can be easily melted. The losses are small, again because of the neutral furnace atmosphere. Carburization of the melt does not take place. Compared with modern high frequency and arc furnaces, the following advantages are claimed: Lower initial cost; applicability of furnace for different metals, from steel to Al; simple construction and operation; small space; no parts to become excessively worn, and long life of furnace lining. The slag is hot and fluid, retains no metal and desulphurizes more readily. EF (3)

High-frequency Electric Furnaces. F. R. SMEDLEY. *Electrical Rev.,* Vol. 123, Nov. 4, 1938, pp. 644-645. Survey. High-frequency furnaces can be divided into those in which a motor generator is used and those of the spark-gap or thermionic tube type. The former are far more efficient and are preferred for most commercial purposes. The chief advantage of spark-gap type over motor-generator type is that any frequency can be obtained from the converter by suitable design of furnace coil, while a motor-generator set works at one frequency. Spark-gap equipment is also more suitable for obtaining the very high frequencies required for very small furnaces, such as those used in laboratories and for melting small amounts of high temperature metals and alloys. Small furnaces are used chiefly for melting Pt, Au and Ag commercially; making alloys where freedom from C is essential and thorough mixing is required, such as special Ni-Fe alloys; and making alloys of the W carbide group. Since the first commercial high-frequency furnace for making high-grade steel was installed, many have been installed, ranging up to 7 tons in size. Maximum capacity has not been reached yet. In earlier stages, provision of a suitable crucible and construction of a sufficiently strong outer casing tended to limit size. Now linings are made by fritting dry powdered lining material placed around a metal crucible-shaped former inside the furnace coil. Steel outer casings are now used on larger furnaces. Casing is shielded from induction by surrounding operating coil with a magnetic shield made of standard transformer Fe laminations. MS (3)

Internal Stresses in Castings. CHARLES W. BRIGGS (Steel Founders Soc. of America) *Welding J., N. Y.,* Vol. 18, Jan. 1939, Suppl., pp. 22-27. Suggests that some of the problems of welding are analogous to those encountered in the foundry, notably the problems of shrinkage and internal stresses. The material presented is mainly a review of published information. Prior to 1925 there was very little information on the mechanics of the formulation of casting stresses. During the past years most of the literature on the subject of casting stresses has been devoted to the relieving of this stress, and to such subjects as annealing temperatures, holding times and amounts of residual stress. Certain test castings, however, have been studied and from these a general idea of the nature of the stresses involved can be obtained. The primary source of internal stresses in castings results from contraction stresses. In 2 hindered contracting castings, acting under like conditions except for cooling rate, the fastest cooled casting will build up the highest stresses. All abrupt changes in section, sharp corners, casting irregularities and hot spots due to temperature gradients are potential positions of stress concentration. It is possible that small tension stresses of 500-1000 lbs./in.^{2}, as developed by contraction, are responsible for hot tear formation. 21 references. CEJ (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

How Is Octopus-like Graphite Formed in Cast Iron? ICHIRO IITAKA & RUIZO SHIOTA. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Nov. 1938, Abstract Suppl., pp. 49-50. In English. Original research. The authors classify the structure of graphite formed in cast Fe as follows: Flake, eutectic, lump, octopus-like and rosette graphite. The so-called octopus-like graphite is formed with the lump graphite as the head and several legs of flake graphite attaching to it forming an octopus-like pattern. In the present paper, a study was made of the conditions under which the octopus-like graphite is formed. Test pieces were made by varying melting temperature, casting temperature, melting time and the percentage of C. Microscopic examination showed that it is the C content that has the greatest effect on the formation of the octopus-like graphite. In a pig Fe, containing 3.5% C, 2.5% Si, 0.68% Mn, 0.48% P and 0.027% S, the octopus-like graphite formation was absent on dilution with pure Fe and on depressing the C content below about 3.4%. With higher C contents, the formation occurs very frequently. Raising the melting temperature tends to suppress the formation. EF (3a)

Investigation of a Rimmed Steel Ingot. A. BOLOTOV & I. SOBORNOVA. *Metallurg,* Vol. 13, Oct. 1938, pp. 12-18. Practical. The steel tested contained 0.07% C, 0.33% Mn, 0.059% P and 0.030% S. It was deoxidized with Fe-Mn, and some Al was added before pouring. Tests were made to determine the extent and distribution of slag inclusions, and the liquation of the admixtures. The inclusions varied from 0.08% to 0.5% and consisted of finely dispersed complex oxides, complex Fe and Mn sulphide, and silicates with varying amounts of MnO, FeO, and also Al_2O_3. Liquation of the admixtures and inclusions was observed. The chief defect of the ingot was the large amount of slag inclusions. These may be decreased by regulating the air volume at the end of the blow to give the smallest amount of FeO in the metal. The slag should also have a minimum of FeO. BZK (3a)

Some Unusual Aspects of Malleable Iron Melting. A. L. BOEGEHOLD (Gen. Motors Corp.) *Trans. Amer. Soc. Metals*, Vol. 26, Dec. 1938, pp. 1084-1121; *Metal Progress*, Vol. 34, Nov. 1938, pp. 557-562. Campbell Memorial Lecture. Suggestions are made as to the possible control of graphitization in cast irons by varying contents of moisture and Fe oxide. Moist air bubbled through a laboratory induction furnace melt for 8 min. gave a gray casting, but when steam was used for 4 min. the fracture was completely white (analysis in both cases was C + Si = 3.79%). Further tests showed that ordinary air at normal humidity had strong power to retain carbide during solidification. Fe oxide in ladles used in the casting of partly gray Fe produced mottles small in size. Moisture and H were found to have a positive power to overcome graphitizing influence of increased C and Si. The prevention of contamination by solid Fe oxide is more important to the production of a white fracture with high Si and C than is the presence of moisture. With low C plus Si the presence of solid Fe oxide causes a gray fracture. Paradoxically Fe oxide acts as a graphitizing agent during solidification, and as a carbide stabilizer during annealing. The presence of Fe oxide makes the Fe more difficult to anneal, which is contrary to the characteristics that would result if increased mottling tendency were produced by the addition of some graphitizing agent, such as Si or Cu. CWH (3a)

Contribution to the Study of Pig Iron for Treating in the Converter (Contribution à l'Étude de la Fonte d'Affinage à Traiter au Convertisseur) P. THIERRY. *Rev. Mét.*, Vol. 35, Oct. 1938, pp. 425-439. Comprehensive review. The 3 principal factors affecting the quality of the Fe are: (1) Chemical analysis; (2) physical heat; and (3) viscosity. The tendency has been to decrease the Si and Mn contents to about 0.15% and 1%, respectively. P is kept at about 1.7%. The main effect of the C is on the viscosity. Viscosity is difficult to measure; but the related property castability can be determined by casting a spiral 8 mm. in diameter and 3 m. long and measuring the length of the spiral actually obtained. Mn and P do not affect the fluidity greatly, but Si and C are very important. The fluidity increases with C up to the eutectic point, then decreases with further increase in C. The superiority of the eutectic composition is most marked for low temperatures. The castability increases with Si up to 0.3%, then goes through a minimum at about 0.5% Si, a second maximum at 0.75%, a second minimum at 0.95%, then gradually increases up to the eutectic composition after which it rapidly decreases. JZB (3a)

Instrument Firing. E. T. W. BAILEY (Steel Co. of Canada, Ltd.) *Steel*, Vol. 103, Dec. 5, 1938, pp. 54-55, 73-74. Describes installation of automatic control on an open-hearth furnace at Hamilton works of author's company. Furnace, of the McKune type, was built primarily to use coke-oven or mixed coke-oven and blast-furnace gas. There are also separate burners for auxiliary high-pressure coke-oven gas. Gases are fed cold direct to furnace ports, and all checker chambers are used to preheat air only. Among instruments which do not control are those for recording temperature of fuels as they arrive at furnace; gas pressures; flow of each gas to furnace; volume of combustion air being supplied; furnace pressures; and temperature of gases leaving the 4 regenerator chambers as well as at inlet and outlet of waste-heat boiler. Of these, the fuel flow-meter is probably the most useful. The most important controlling instruments are those for controlling air-gas ratio or combustion; furnace pressure; roof temperature; and automatic reversals. Combustion control has reduced fuel consumption 500,000 B.t.u, per ton over manual operation. MS (3a)

3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Furnaces Operate on Clean Oil. E. H. CARRUTHERS (Goulds Pumps, Inc.) *Foundry*, Vol. 66, Nov. 1938, pp. 30, 87. Practical description of brass founding at Goulds Pumps, Inc., with special reference to the use of fuel oil for the furnaces. Oil burning system maintains steady melting speeds and flame conditions, which are reflected in the quality of castings and fuel economy. Records show that melting 85-5-5-5 brass and raising to a temperature of 2200° F. takes an average time of 50 min. Fuel consumption averages 24 gal./100 lbs. P-bronze brought up to a temperature of 1900° F. averages 35 min. Fuel consumptions are 1.7 and 1.2 gal./100 lbs. VSP (3b)

Manganese Bronze Propellers. *Shipbuilder & Marine Eng. Bldr.*, Vol. 45, Oct. 1938, p. 553. Descriptive. The cement molding process (Randupson process), in which a mixture of silica sand, cement and water is used in place of green or dry sand and loam, is described with reference to its application for the manufacture of high tensile brass (ship) propellers. Castings produced by the process are close grained and denser and therefore more resistant to corrosion and erosion, as well as more true to pattern, due to the rigid nature of the cement sand mold. JWD (3b)

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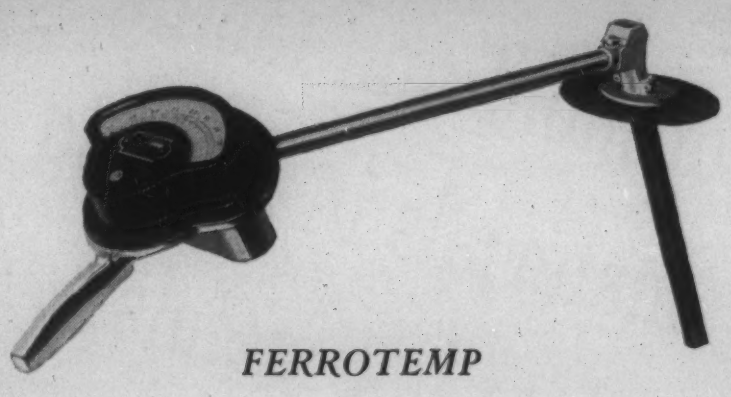

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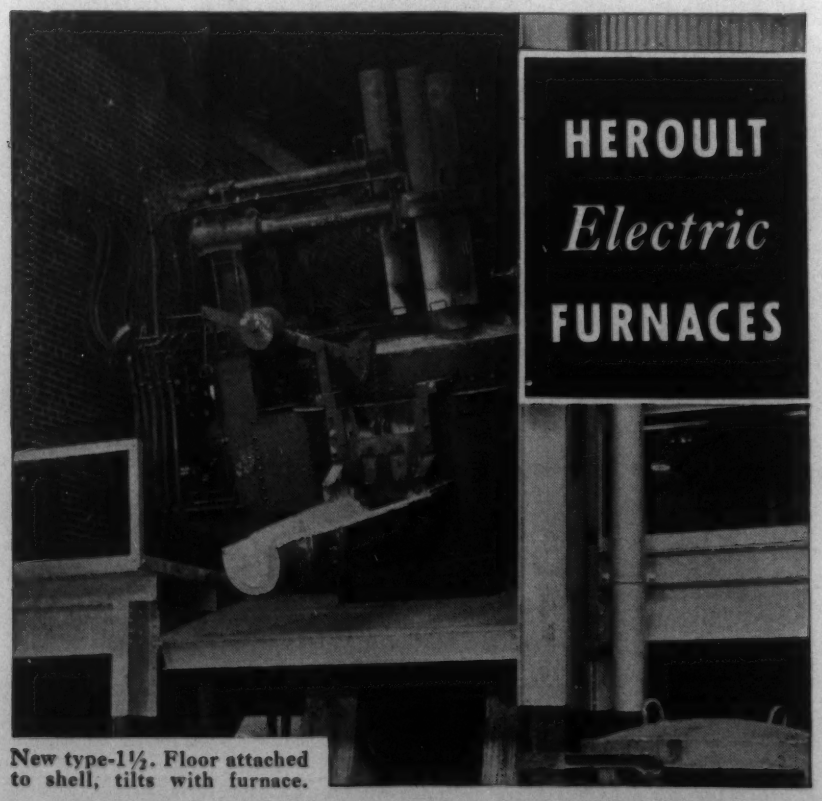

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UNITED STATES STEEL

Light-metal Sand and Permanent Mold Castings (Leichtmetall-Sandguss und-Kokillenguss) GEORG MECKBACH. *Maschinenbau Betrieb,* Vol. 17, Dec. 1938, pp. 633-635. Practical. Principle of the 2 methods is outlined. When casting into sand molds, the grain of the sand shows on the surface. The permanent mold reproduces only its metal structure; the surface is practically smooth. Some sand particles will always stay in the surface of a sand casting, which is detrimental to machining. Because the "skin" of chilled castings is very thin allowances for machining can be as small as 0.5-0.75 mm. as compared with 1-2 mm. for sand castings; tolerance of ±0.1 mm. for small parts, ±4% for larger ones can be maintained by metal molds. Deviations between the individual parts can be avoided on chilled castings since the mold parts are rigidly connected (hinges, etc.), with consequent saving on machine tool readjustment. The high heat conductivity of the iron or steel mold has a favorable influence on the structure. Too drastic a quench is prohibited by preheating the mold to 300°-400° C. The grain becomes finer and the surface becomes denser, with increase in resistance to corrosion; it can be oxidized more readily by the Eloxal-process; it improves its safety under high air, water or gasoline pressures (up to 20 at.); machining properties are improved, the tools are saved, accuracy increased. The cost for Fe or steel molds is 50 to 10 times as high as for sand molds. They are chosen, therefore, for quantities above 500-1000 pieces, in which cases their use is more economical, in addition to the improvements outlined. Certain pieces are not suited to chill casting. Although the molds for chill castings have to be made with great care, the amount of spoilage and the size of lugs and risers are greater in sand mold casting. RPS (3b)

Core Making in the Brass Foundry. N. K. B. PATCH. *Foundry,* Vol. 66, Nov. 1938, pp. 31, 82. Practical discussion of characteristics and use of cereal and other H_2O soluble binders. Cereal binders may be mixed with a variety of sands that break down under relatively low temperatures. Where binders are used with a large proportion of molding sand added to usual core sand binders, or beach sand, resulting core has very smooth surface and imparts satisfactory surface to castings of Al-base alloys, Zn-base alloys and the like. Amount of H_2O to be added for preparing sand where H_2O-soluble binders are used varies with different kind of binders. Best baking temperature for the cores is 350° F. Ample venting should be provided, and vents should be led to part of core print from which gases may escape through mold. Glue-bonded cores are used only under extreme conditions. Cores made with rosin or pitch binders show reasonable permeability if properly baked. With large cores, free venting from the center is advisable. Loam cores in brass foundry are required only when large castings are to be made. Includes some general rules to be observed in core making. VSP (3b)

The Application of the Söderberg Electrode in Aluminum Furnaces (Die Anwendung der Söderberg-Elektrode in Aluminiumöfen) M. SEM. *Aluminium,* Vol. 20, Dec. 1938, pp. 844-847. Practical. The electrodes are made of the same raw materials as ordinary C electrodes, but each consumer mixes them himself and they are baked during the process in the furnace in which they are used; the baking of the electrodes is done by the waste heat of the furnace, in contradistinction to the finishing of the whole electrode in other types of electrodes before their use. The electrode is usually subdivided into 10, 12 or even more single electrodes, so that new, half used up and almost entirely burnt up electrodes are found side by side in a furnace. Some furnace types are described for metallurgical purposes and for the production of cryolite. Ha (3b)

The Application of Artificial Core Binders in the Non-ferrous Metal Foundry (Ueber die Anwendung künstlicher Kernbindemittel in der Metallgiesserei) *Giessereipraxis,* Vol. 59, Oct. 23, 1938, pp. 439-442. Why the application of core binders in German non-ferrous metal foundries is not so advanced as in Fe foundries is discussed. In describing the particular case of the production of valve heads, the considerable advantage derived from the use of core binders is shown. The application of pure quartz sand cores with oil core binders is not advised for non-ferrous foundries. GN (3b)

Pores in Die Castings and Their Elimination (Poren in Spritzgussteilen und ihre Vermeidung) J. GERBER. *Tech. Zentralblatt prakt. Metallbearbeit.,* Vol. 48, Aug. 1938, pp. 580-582; Sept. 1938, pp. 653-654. Practical. The tensile test values given for die casting alloys were obtained on specially cast tensile test bars. These strengths are not often attained on the actual casting, owing to the unavoidable presence of pores. Practical examples show how designer and die caster may closely approach the maximum strength by proper design and casting. EF (3b)

Magnesium Foundry Practice. W. C. DEVEREUX (High Duty Alloys, Ltd.) *Iron Age,* Vol. 142, Dec. 22, 1938, pp. 25-27. Abstract of paper read at Polish International Foundry Congress and originally published in Foundry Trade Journal. See *Metals and Alloys,* Vol. 10, Jan. 1939, p. MA 20R/1. VSP (3b)

4·WORKING

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER AND H. W. GRAHAM, SECTION EDITORS

Researches on the Deep-drawing Process. SHINJI FUKUI. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1422-1527. In English. Extensive original research. The author calculates a new relation between the drawing force and the stresses induced in a blank. He explains qualitatively the dependence of the drawing force on the shape of die and other factors, and points out that experimental measurement is the only way to determine the drawing force. He constructed an experimental apparatus using piezo-electricity of 2 quartz crystals to record continuously both drawing and holding forces. Experiments are made on plain and on redrawn Fe and Al blanks. Deformations and strains induced in the blank were measured. The experimental results refer to drawing and redrawing of circular cylindrical shells. The thickness of the blank is 0.5 mm. and the punch 18 mm. The forms of punch and die are considered to be very important. The author holds that conical dies should be employed to reduce the drawing force in order to facilitate the working and to obtain results of high quality. The various factors involved, such as thickness, annealing, temperature, lubricant, die clearance, drawing speed, etc., are exhaustively studied and the results presented in 47 tables and 62 illustrations. EF (D-4)

Surface Phenomena in the Cold Working and Recrystallization of Metals (Phénomènes Superficiels dans l'Écrouissage et de la Recristallisation des Métaux) GEORGES-A. HOMÈS. *Bull. Classe Sciences Acad. Roy. Belgique,* Vol. 24, Ser. 5 (3), 1938, pp. 147-158. Original research. The recrystallization of mild steel and Zn was studied microscopically and by X-rays. The metals were submitted to tensile stress or to polishing, or to both. Attention is focused on the type of stress, distribution of stress, presence of discontinuities and previous history of the specimens. Cold working in tension propagates from the surface into the interior regions of the metal. Polishing produces a superficial cold working. Recrystallization begins at the surface and extends into the interior. The shape of the new crystals are often masked by the contour of a previous crystallization. The hypothesis that the recrystallization centers are those parts where the stress has been greatest, is confirmed. For the definition of the state of surface of a metal, a combined study by microscopy under ordinary and polarized light and by electron diffraction is urged. EF (E-4)

On the Theory of the Origin of Rolling Textures in Face-centered Cubic Metals. M. R. PICKUS & C. H. MATHEWSON (Yale Univ.) *J. Inst. Metals,* Vol. 64, 1938, Advance Copy No. 821, 22 pp. Theoretical. A view is developed that not only accounts for all of the rolling textures that have been observed in face-centered cubic metals, but also assigns to each a relative degree of importance. The textures listed in order of their stability as developed by the analyses follow, where the direction indicated the direction of flow and the plane the plane of compression: [112], (1-10); [001], (100); [001], (110); [111], (-1-12); [101], (010); [101], (101). 17 references. JLG (E-4)

Practical Notes on Allenite Cemented Tungsten Carbide Tipped Cutting Tools. *Edgar Allen News,* Vol. 17, Dec. 1938, pp. 266-269. Descriptive review. The properties of the sintered W carbide material used for tools are described, and a very comprehensive table is given for cutting velocities, shapes and angles of the cutting tips, and finishing velocities for steels, cast Fe, non-ferrous metals and several non-metallic materials, such as glass, porcelain, plastics and marble. Ha (G-4)

Press Tools for Non-ferrous Metals. Piercing, Swaging and Impact Extrusion. R. KIRCHNER. *Metal Ind., London,* Vol. 53, Dec. 2, 1938, pp. 537-538. The most serious problem confronting the press tool engineer is the determination of the number and sequence of operations and proper application. The progressive pierce, notch, form and shearing tool for connecting strip; the 7-stage progressive tool for Al cup, the perforating tool for brass cup, the swaging tool for brass spindles, and the impact extruding tools for metal containers are described. These are all examples of press tools for medium or large quantity production. For small production jobs the major problem is balancing tool cost and holding total expenditures per piece at minimum. A few of the usual methods of approaching this problem are by simplification of orthodox type of tools, eliminating hardening, using castings for forming and drawing tools, standardizing types of tools, tool units and component parts and by employing tools of original or unusual design. RWB (D-4)

4a. Ferrous

Forged Steel Rolls. J. R. ADAMS & H. L. WILSON, JR. (Midvale steel Co.) *Iron Steel Engr.,* Vol. 15, Dec. 1938, pp. 48-67, 73. Practical. Steel rolls are forged from big-end-up ingots of electric or acid open hearth steel. Rigid heating cycles are followed in heating roll ingots for forging and in subsequent anneal to obtain the best possible structure. After preliminary machining, the rolls are given a pre-hardening treatment consisting of various quenches and draws, dependent upon the composition, size and purpose of the rolls. This treatment is checked by microscopic examination. The rolls are next finished machined; wherever possible sharp corners, thin sections, re-entrant angles, large changes in section and deep grooves are eliminated. Rolls are heated for hardening in specially designed furnaces and are quenched in air, oil, water or other solutions using specially designed fixtures for the protection of journals, shoulders, wobblers, keyways, fillets and champfers during cooling. Rolls are stress relieved after hardening in air furnaces, oil baths, salt baths and electric furnaces. Hardness is determined with a sceleroscope; Monotron and Rockwell tests are made on smaller rolls. Remaining machining is completed and the rolls are finish-ground. Successful grinding is accomplished only after careful application of proper wheels, grinding speeds and cuts, grinding compounds, etc. Grinding wheels should be soft and free cutting, otherwise excessive heating results and the roll may be burned. Bad chatter, pronounced transverse lines, slight out-of-roundness cannot be removed with a succeeding fine grit wheel. Touching the face of a stationary roll with the revolving grinding wheel may cause a grinding burn that may result in roll cracking or spalling. Etching with 7% nital solution darkens the burned areas; since tempered martensite is blackened, the unburned area remains white. Regrinding and re-etching are continued until all traces of the burning are removed. Too heavy grinding or the use of too hard a wheel may cause grinding checks and onion-skin spalling. Accidents in rolling frequently play an important role to subsequent roll failures. The heavy reduction of thick metal may cause the burning of the faces of rolls. Careful preheating of rolls before rolling operations avoids failures from rapid heating of the roll face from heavy reductions. Preheating the coolant used prevents too steep a temperature gradient, which causes high tangential stresses and may cause cracks. Overheated journals may cause severe spalling on the ends of the bodies adjacent to the necks. Care should be exercised in the storage of hardened steel rolls. Applications for forged rolls are discussed. CBJ (E-4a)

The Selection of Forging Materials. W. NAUJOKS (Steel Improvement & Forge Co.) *Ind. Heating,* Vol. 5, Oct. 1938, pp. 914-916; Nov. 1938, pp. 1016-1022; Dec. 1938, pp. 1114-1116. A general survey of the ferrous and non-ferrous metals used for forging; their composition, effect of Mn, Si, S, P, Ni, Mo, Cr, V, W, Se and Zr on properties, selection of materials for definite purposes, the various types of SAE steels, and fields of application for each type are dealt with. Ha (D-4a)

The Manufacture of Seamless Steel Pipe in the Plants of the National Tube Company. EDWIN C. WRIGHT & STEVENSON FINDLATER (Natl. Tube Co.) *J. Iron Steel Inst.,* Advance Copy No. 17, Oct. 1938, 15 pp. Description. A short history of the company is given, with particular reference to the growth of the seamless tube process that now represents 60% of the company's production. JLG (D-4a)

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The Production of Flakes by Treating Molten Steel with Hydrogen and the Time of Cooling Necessary to Prevent their Formation. R. E. CRAMER & E. C. BAST (Univ. Illinois) *Am. Soc. Metals,* Preprint No. 14, 1938, 15 pp. Research to determine effect of H content and cooling rates after rolling on flake formation. A number of ½ x 3 in. bars from six 5-ton ingots (C 0.66-0.77 Mn 0.63-0.87%), 3 of which were treated with H in the mold during solidification, were sectioned at the hot saws and cooled at controlled rates through various temperature ranges by packing in insulated boxes. Control specimens were cooled on the mill floor. Specimens were macroetched in 50% HCl to reveal flakes. Flakes were found to be more numerous in the control specimens from H-treated ingots. The time required in slow cooling between 900° and 200° F. to eliminate flakes varied from 3 hrs., 20 min. to 9 hrs., 11 min., depending on the tendency of the steel to develop flakes. Flakes developed in most of the bars below 300° F. The results of these experiments are not meant to apply to bars of other compositions and dimensions. A survey of recent literature on flakes in steel is presented. Many investigators are associating the development of flakes with the presence of H in steel. See also Metals and Alloys, Vol. 9, Apr. 1938,, p. MA 240 R/6. HLW (D-4a)

Relations between Hydrogen and Flakes in Steel. KANJI MATSUYAMA, KIYOSHI SASAKAWA & TSUNEYO IKI. *Tetsu-to-Hagane,* Vol. 24, Mar. 25, 1938, pp. 234-247. In Japanese. Research. Ni-Cr and other structural and stainless steels were heated at 1150° C. in a current of H_2 or air for 6 hrs. and quenched in water, then tempered at 820° and 650° C. for 1 and 4 hrs., respectively. Further, H_2 or N_2 was introduced into the steel melt before pouring. The presence of flakes was investigated micro- and macro-scopically. Flakes appear in steel containing H_2, but are caused not only by H_2 but by thermal and transformation stresses. Chemical composition of steel also has an effect on the formation of flakes. TS (D-4a)

Machinability of Steels, Ratings Based on Relative Speed of Removing Metal. J. SORENSON & W. GATES. *Product Eng.,* Vol. 10, Jan. 1939, pp. 12-14. Practical. Combination tables and charts are given for some 100 standard steels giving ultimate strength, elastic limit, elongation, reduction of area, hardness, machinability rating and machining time index. The application of the data to the calculation of shop cost for machining is explained. Ha (G-4a)

4b. Non-Ferrous

Machining of Magnesium Alloys; Reaming-Milling-Sawing-Tapping-Broaching-Filing-Grinding-Cooling and Lubrication (Spangebende Formung von Magnesiumlegierungen; Reiben-Fräsen-Sägen-Gewindeschneiden-Räumen-Feilen-Schleifen-Kühlung und Schmierung) E. RAUSCHER. *Maschinenbau Betrieb,* Vol. 17, Dec. 1938, pp. 613-615. Practical. Spiral-teeth tools must be used for reaming, and if teeth are straight, there should be an odd number of them. Reamers may be used that are ground as are tube bits. All milling operations can be easily applied to Mg alloys. For wide, long surfaces, cutter heads of light metal bodies are used; the cutting edges are either high-speed steel or sintered carbide. Face mills must have large gaps well rounded off at the bottom. For finger mills, the same rules apply as for spiral drills. Disc mills as well as circular saws must be ground thinner toward the center. Slight crossing is used for large thin saws as well as for hand saws. Special formation of teeth is recommended. Threads produced by taps or dies should be made with special tools, if possible, the tool to be designed so as to reduce friction. Automatic-opening die heads should be used on turret lathes and automatic screw machines. Small taps have 2, larger ones 3 cutting edges. Broaches should be provided with chipping angles. The clearings are chosen so as to avoid sticking. Rough cut is used for files that are best made by milling with inclined or sector-shaped cut. Grinding is usually done wet. Crude petroleum or very dilute soda solution is used as cooling medium. After grinding, the pieces must be dried and covered with acid-free oil or petroleum so as to prevent staining. When ground dry, dust has to be sucked away. Mg alloys are usually machined dry. If a lubricant is used (on screw machines), it should have a high ignition point. A special cooling liquid has been developed that acts as a fire extinguisher in case of ignition. Compressed air is frequently used for cooling and chip removing; a condensate trap must be provided in the line. RPS (G-4b)

Some Experiments in the Grain Refinement of Duralumin. I. IGARASHI. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Sept. 1938, pp. 466-475. In Japanese. Original research. The tensile strength and endurance limit of duralumin decrease as the grain size increases. Fine grained structure is therefore very important, and may be obtained by one of the following methods: (1) Keep the percentage of cold extension less than 2 or greater than 10. (2) Increase the percentage of reduction, and lower the temperature of forging. (3) Increase the percentage of Mn up to 1.2. NS (D-4b)

5·HEAT TREATMENT AND HEATING

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O. E. HARDER, SECTION EDITOR

Design of Specialized Fuel Fired Furnaces. J. L. RUNDLE. *Heat Treating Forging,* Vol. 24, Oct. 1938, pp. 522-526; Nov. 1938, pp. 575-577. Discusses principles. Considers burners and combustion chambers; temperatures, temperature distribution, and pressures in combustion chamber; heat transfer to working chamber; temperature distribution in working chamber; flue ports; and indirect heating. Very high rate of heat liberation is ordinarily of no advantage. The combustion chamber should be too large rather than too small, and combustion should be complete before the gases leave the chamber. Temperature of the combustion chamber may be determined (or better, estimated) from a knowledge of fuel conditions (heat input) and the various heat loss factors: wall conduction, port hole radiation, and convection by furnace gases. Efficient, even temperature distribution in the combustion chamber is favored by greater chamber width. Small ports aid in attaining even (high) gas velocity through the ports, but they also reduce the direct radiation area to the work chamber. The designer has considerable latitude in selecting size, number and shape of ports, and can usually achieve an excellent balance of opposing factors. Many diagrams are used to illustrate heat flow paths and rates, pressure and velocity distribution, etc. MS + FPP (5)

Electric Resistance Furnaces. A. J. G. SMITH. *Electrical Rev.,* Vol. 123, Dec. 9, 1938, p. 824. Descriptive. A vertical pit-type furnace has been developed that can be used for all heat-treating processes involving temperatures up to 950° C. There are 2 separate systems of heating elements. For temperatures up to 650° C., the furnace works in conjunction with a heating shaft at side of working chamber. The shaft is provided with a series of withdrawable heating elements at the top and a forced circulation fan at the bottom for circulating the heated air with great velocity through the charge in the working chamber via top and bottom flues. For high temperatures, communication with the shaft is shut off by dampers of special heat-resisting steel in the flues, and the furnace operates as an independent unit in the normal way without air circulation. The cover for the working chamber is hydraulically operated. MS (5)

Controlled Heat Dissipation. J. G. COUTANT. *Iron Age,* Vol. 142, Oct. 13, 1938, pp. 247-248, 252-254. Practical description of advances made in construction of annealing furnaces using light weight refractories capable of controlling rate of heat dissipation. Pit type annealing furnaces for chilled car wheels are considered and data on the calculations used in the design of these furnaces given. VSP (5)

5a. Ferrous

O. E. HARDER, SECTION EDITOR

Electrode Salt Baths. *Wild-Barfield Heat Treatment J.,* Vol. 3, Dec. 1938, pp. 31-33. Descriptive of a new electric salt bath furnace designed especially for hardening high speed steel. The furnace is 3-phase, and employs 3 electrodes 120° apart around the bath periphery. Heat is generated by the passage of current through the salt; current passage also produces a stirring action in the molten salt. The bath lining is of specially selected bricks, with recesses to accommodate the electrodes. In operation, a set of small auxiliary electrodes is inserted to "start" the melting of the solid salt, more and more of which is added until the auxiliary electrodes can be withdrawn and the main electrodes used. The furnace is circular and is covered with an easily-removable hood and fume-removal system. These are made easily removable because the corrosive nature of the hot salt necessitates replacement of lining and electrodes after the bath has been in use "for some time". Complete description of electrical control, temperature indicating system, etc. are given. FPP (5a)

Automatic Charging Devices for Salt Bath Furnaces (Selbsttätige Beschickungsvorrichtungen für Salzbadöfen) W. UNTERKIRCHER. *Durferrit Mitt.,* Vol. 7, Oct. 1938, pp. 51-67. Practical. Mechanical transportation of parts to be hardened through preheater, salt baths, quenching and cleaning tanks is especially recommended for heat treating oil hardening steels and carburized case hardening steels. Fully automatic charging devices are suggested when large amounts of similar pieces are to be heat treated; semi-automatic devices should be applied with small turnover or with difficult quenching procedure. A device, fully automatic, is described for the treatment of oil hardening and carburized case hardening steels, distinguished by many safety features. When space is lacking, a revolving apparatus is recommended. The furnaces are arranged in a circle. Charging devices of simple construction for manual quenching are also considered. GN (5a)

Cyaniding of High Speed Steel. D. A. PROKOSHKIN & V. S. TSAREGORODETS. *Metallurg,* Vol. 13, July/Aug. 1938, pp. 28-39. In Russian. Research. Steel samples containing 0.74% C, 4.02% Cr, 18.4% W and 1.27% V were first heated in salt baths to 800°-850° C. in 12-15 min. and then to 1280°-1300° C., and kept at that temperature for 2-3 min. The samples were then held for 40 min. in a muffle furnace at 550°-560° C. and cooled in still air to room temperature. After polishing, they were subjected to cyaniding in baths of 90% NaCN, 47% KCN+53% NaCN, 90% $K_4Fe(CN)_6$ + 10% KOH, at 560°-570°, 560°-570°, and 550°-560° C. respectively. During the first 15 min. the hardness rises considerably, but longer periods produce a more gradual increase. The C in the steel became concentrated on the surface and formed a cementing layer, but the N diffused deeper in the Fe. BZK (5a)

The Electrical Surface Hardening of Machine Parts. I. V. BURGSDORF & M. B. MAKOGON. *Metallurg,* Vol. 13, July/Aug. 1938, pp. 9-21. In Russian. Practical. Satisfactory results were obtained in the surface hardening of machine parts using the Vologdin (high frequency current) method. The hardened layer was 3.0-3.5 mm. deep, and the hardness was 60 Rockwell C. At a depth of 3 mm. the hardness was 54 Rockwell C. The layer showed even gradation from surface to unhardened core. The structure was fine-grained with no traces of overheating; the martensite needles were very small. At 1.75 mm. small troostite grains appeared, at 2.5 mm. ferrite made its appearance, and at 3.25-3.5 mm. there was an abundance of small-grained ferrite and troostite. The distortion of parts did not exceed that produced by other methods of surface hardening. BZK (5a)

The Heats of Formation of Various Nitrides. *Shun-ichi Satoh. Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1356-1361. In English. Original research. Not only the properties of the elements themselves, but the properties of their corresponding compounds are also frequently periodic. Thus, the heats of formation of nitrides of the elements are tabulated in a "periodic chart" and graphically presented by plotting atomic number against heat of formation. Periodic curves are obtained that permit rough prediction of the heats of formation of nitrides hitherto unknown, such as:

$$\tfrac{1}{2}\,(N_2) + [As] = [AsN] - 33.9 \text{ k. cal.}$$
$$\tfrac{1}{2}\,(N_2) + [Sc] = [ScN] + 75.0 \text{ k. cal.}$$
$$\tfrac{1}{2}\,(N_2) + [Hf] = [HfN] + 78.3 \text{ k. cal.}$$

For previous work, see also *Metals and Alloys,* Vol. 9, Nov. 1938, p. MA 673 R/7. EF (5a)

The Effect of Sulphur Gases upon Scale Formation during Heat Treatment. B. A. MOROZOV & A. V. TURSUNOV. *Metallurg,* Vol. 13, July/Aug. 1938, pp. 22-27. In Russian. Practical. Presence of about 0.025% S gases in the combustion products (oxidizing atmosphere) at 800°-860° C. resulted in a sharp increase of scaling in steel of 1.0% Cr and 4.0% Ni. When the S gases reach 0.05-0.1%, the metal surface becomes strongly saturated with S. The scaling proceeded in the form of a strongly corroded uneven layer. This loss is considerably reduced in a neutral atmosphere and is totally absent in a reducing atmosphere. High S fuel may be used in an oxidizing atmosphere provided the combustion products are diluted with air to contain less than 0.025% S gases. BZK (5a)

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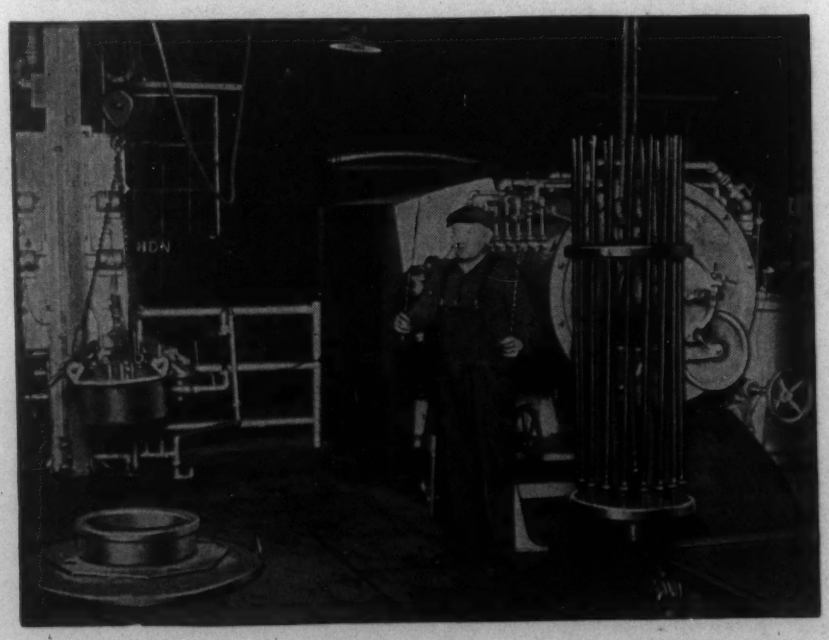

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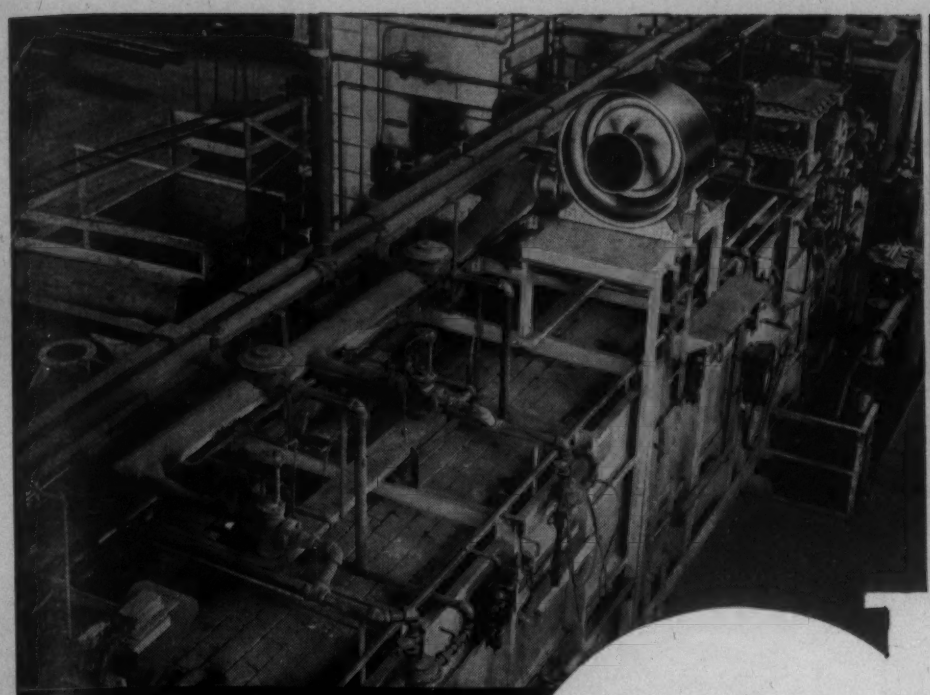
Effect of Primary Austenite Grain Size on the Properties of Steel. IWAN FESZCZENKO-CZOPIWSKI & BOLESLAW STEGENTA. *Hutnik,* Vol. 10, No. 11, 1938, pp. 559-573. In Polish. A discussion of the effect of "primary" austenite grain size as determined by carburization or a similar method points out that preliminary heat treatment largely removes the differences between the mechanical properties of coarse and fine-grained steels, but does not change the nature of the primary austenite grains. Heat treatment of steel with fine primary austenite produces, as a result of allotropic change, a finer secondary grain than that obtained in the case of the same steel with coarse primary austenite grain size. Extensive hot plastic treatment decomposes the primary austenite grains to some extent, the decomposition sometimes beginning within the grain. The grain size at a fracture after hardening depends not only on the primary austenite grain size, but also on the form of cementite before hardening. Primary austenite grain size can be only qualitatively estimated by comparison of fractures of samples hardened at different temperatures the method of normalizing at 925°-980° C. (Przeglad Techniczny, No. 18, 1936, pp. 550-552) was found to be most suitable for rapid microscopical determination of approximate grain size. The McQuaid-Ehn method, or its modification, as suggested by the writer (heating for 4 hrs. at 900°), give better results. 15 references. JGT (5a)

Electric Heat Treating of Seamless Chromium-molybdenum Tubes. F. VDOVIN. *Stal,* Vol. 8, May 1938, pp. 48-54. In Russian. Original research. Steel tubes 20 mm. in diameter with a wall thickness of 0.75 mm., containing 0.30% C, 0.22% Mo, 0.85% Cr, 0.55% Mn, 0.27% Si, 0.022% S and 0.015% P, were heated to 800°-950° C. by passage of an a.c. of 450, 680 or 800 amps. and allowed to cool in air. Heating required approximately 360, 80 and 30 sec., respectively. A sorbitic microstructure with the best mechanical properties was obtained by heating to 880°-920° C. Tests made on tubes of various sizes gave the same results, except that the largest tubes tested, 65 mm. in diameter by 1.5 mm. thickness, required heating to 1000° C. All tubes heated to their proper temperature range in 1 min. satisfied and, in most cases, considerably exceeded the specifications for tensile strength (100,000 lbs./in.^{2}) and elongation (11%). HWR (5a)

The Change of Mechanical Properties and Microstructure of Gray Cast Iron due to Heat Treatment. TAKETO YOKOYAMA & HIROSHI KISHIMOTO. *Tetsu-to-Hagane,* Vol. 24, Apr. 25, 1938, pp. 321-326. In Japanese. Gray cast Fe (3.16% T.C., 2.30% graphite, 1.12% Si, 0.43% Mn, 0.63% P) whose tensile strength and Brinell hardness were 31,000 lbs./in.^{2} and 240, respectively, were subjected to various heat treatments, *viz.* quenching at 750°-1050° C. in oil, water and salt-bath and tempering at 150°-300° C. The specimen quenched at 800° C. and tempered at 250° C. showed the highest tensile strength, *viz.* 43,000 lbs./in.^{2} The highest Brinell hardness (550) was obtained from the sample quenched at 800°-850° C. Change in microstructure was the same as in the case of steel, except, of course, for the graphite. The specimen quenched at 800°-850° C. and tempered at 150°-200° C. showed the highest resistance to 10% HCl solution. TS (5a)

American Soaking-pit and Reheating-furnace Practice. FREDERICK M. GILLIES & EDWIN D. MARTIN. *J. Iron Steel Inst.,* Advance Copy No. 8, Oct. 1938, 30 pp. Up-to-date review. A detailed description of the various types of soaking pits and reheating furnaces used at different American plants. Regenerators and recuperators used with the furnaces are also discussed. Poor quality of heating takes a heavy toll from forging and rolling operations; American industry came only gradually to recognize this and to spend, as it has since 1934, $15,000,000 on new fuels, regenerators, recuperators, control systems, refractories and heat resisting alloys, and on new furnace designs. In 1937 alone 150 new soaking pit installations were made in America. Four distinct types of soaking pits are discussed, and statistics are given that offer a cross-section of present American equipment and practice. JLG (5a)

Quenching into Hot Salt (Härten im Warmbad) R. VOEGELIN. *Durferrit Mitt.,* Vol. 7, Oct. 1938, pp. 68-79. Practical. The theoretical principles underlying the quenching of steel into hot salt, are outlined, and the advantages of this heat treating method are discussed. Potassium nitrate bearing salt baths proved most successful; a mixture melting at 140° C. is generally applied. Hot salt quenching in general is only applicable to alloy steels, such as Cr-Ni, Cr-Ni-Mo and Cr-Mo carburizing steels and all kinds of tool steels commonly oil hardened. Recently, however, hot-hardenable low-alloy steels have been developed. If small quantities are to be quenched, the common types of quenching furnaces are satisfactory. If large quantities require treatment, air cooling is too slow. Internally heated electric salt bath furnaces are recommended, such as those of Kärcher, in which the bath tank is water cooled outside. Such water cooling proved many times more effective than air cooling. GN (5a)



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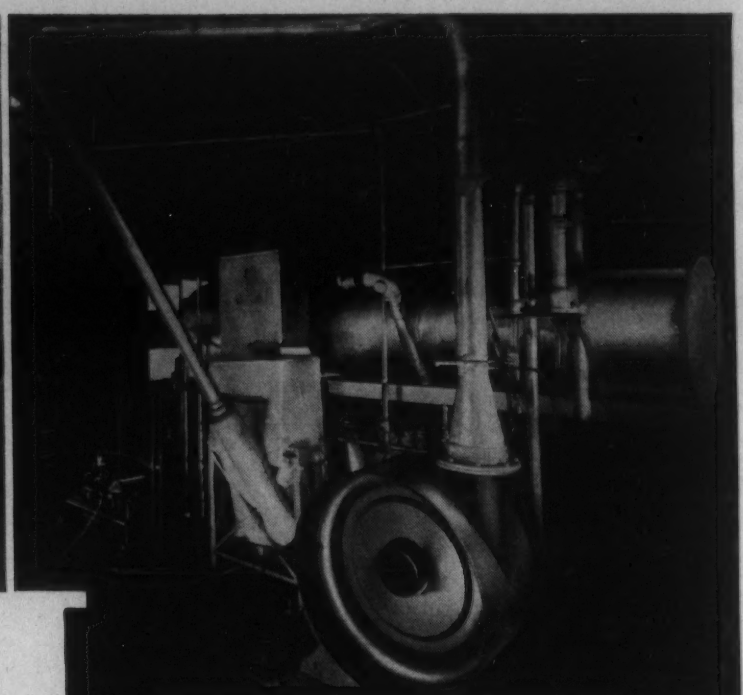

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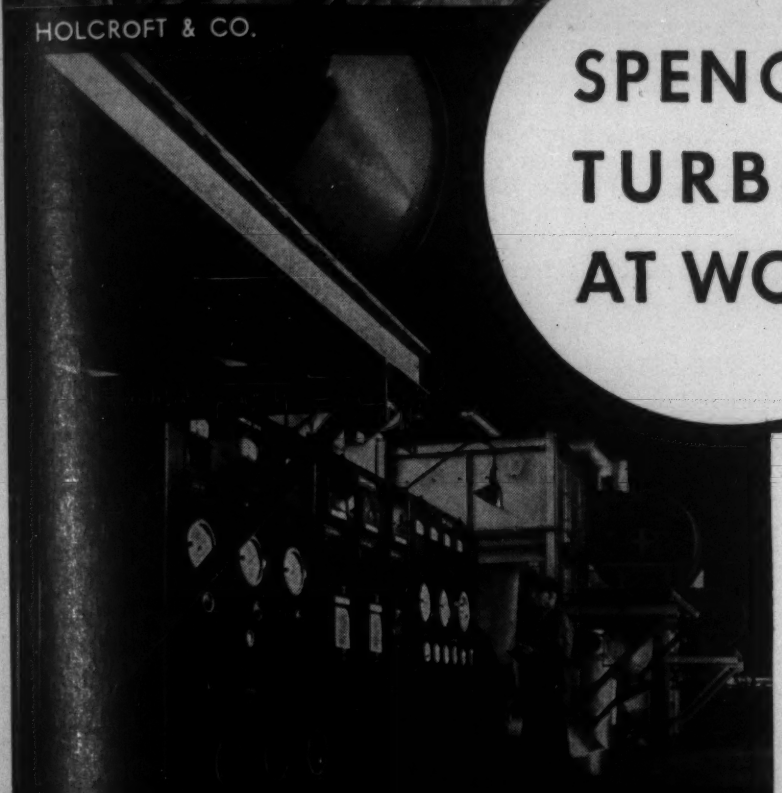

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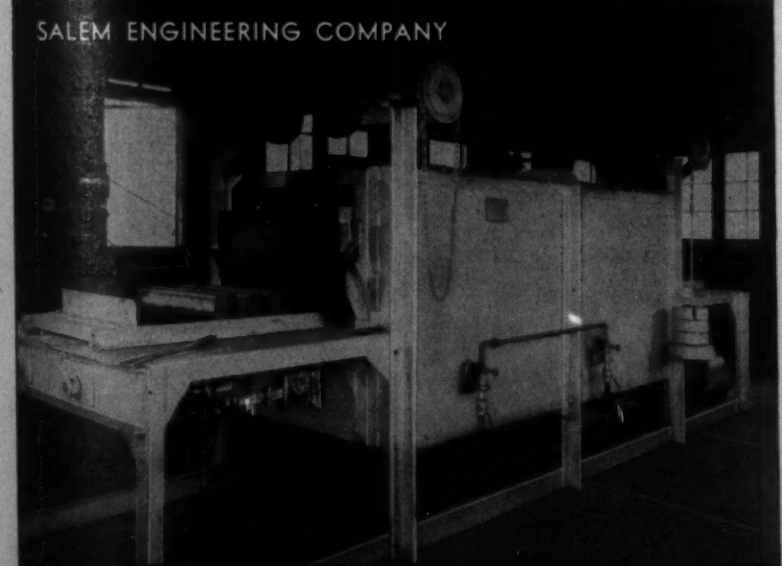

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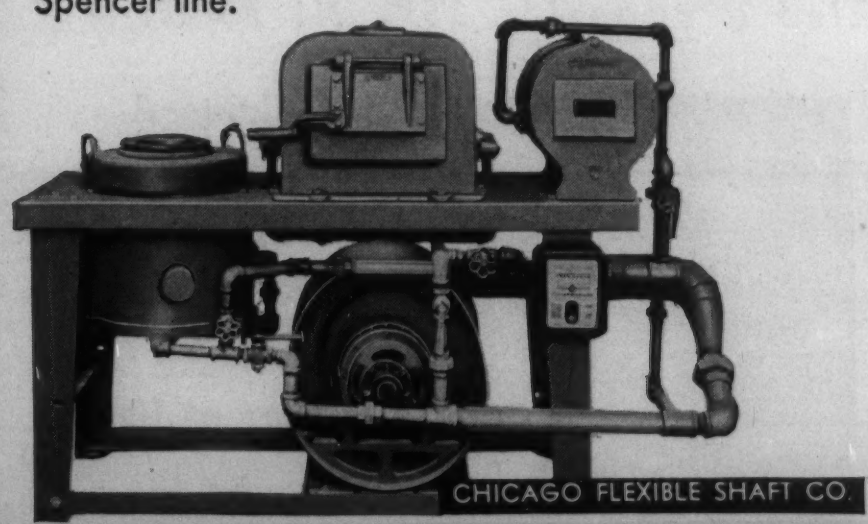

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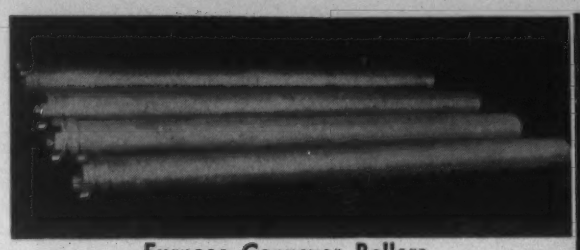

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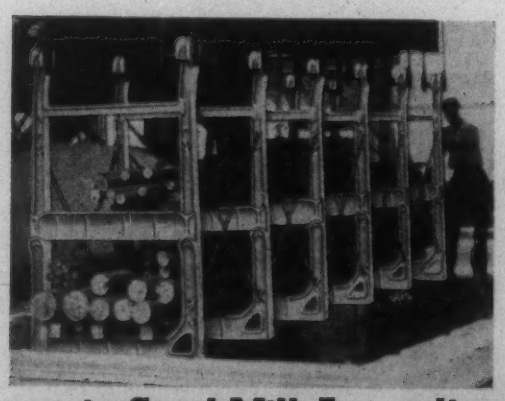

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Hardness Factors. Wm. Conley & Donald E. Roda. *Steel*, Vol. 103, Dec. 12, 1938, pp. 56-58. Original research, showing that most uniform results in hardening strip steel parts are obtained when size of quenched section is in agreement with C and Mn content. Steels used contained (1) 0.38% C and 0.68% Mn, (2) 0.58% C and 0.66% Mn, and (3) 0.58% C and 0.78% Mn. "The microscope showed that the austenitic grain size was same for these 3 steels" is the only "information" on grain size given. Sections were built up of ½ in. by 0.04 in. tensile test-pieces. They were held at a hardening temperature of 1480° F. for 5 min. and quenched in oil, at room temperature, or in salt bath at 625° F. After hardness readings were made, oil-quenched steels were drawn at 625° F. for ½ hr.; in the constant temperature transformation, the parts remained in the hot salt 15 min. Hardness readings were again taken along center of tensile section and 1-in. grip section and across test-piece. Tensile tests were then made. Variation of C content between steels 1 and 2 caused maximum hardness variation of 12 points Rockwell C in a section 0.08 in. thick. Variation of Mn content between steels 2 and 3 produced maximum hardness variation of 30 points Rockwell C in a section 0.12 in. thick. When width of quenched part was increased to 1 in., Mn in steel 3 was able to maintain hardness in spite of greater mass. Drawing greatly reduced the variations in hardness found in the hardened state. Results of tensile tests indicated that strength bears a close relation to hardness. Every point change in Rockwell hardness resulted in about 4,500 lbs./in.^{2} difference in maximum strength. In no case did a tensile test-piece fail through a section containing a Rockwell indentation. Readings across test-piece, instead of lengthwise, showed only a few points variation in hardness. Hot salt quench gave more uniform results than oil quenching and drawing. For all sections over 2 pieces of the hot salt-quenched samples, strength values were higher for the surface than the center pieces. For 3-piece section, hardness increased from one steel to the other by very uniform steps not shown in the oil-quenched and drawn tests. MS (5a)

Plain Carbon-tool Steels, Their Heat Treatment and Applications (Unlegierte Werkzeugstahle, ihre Warmebehandlung und Anwendungsmöglichkeiten) Erich Eichwald. *Automobiltech. Z.*, Vol. 41, Dec. 25, 1938, pp. 634-638. Useful data compilation. Plain C-tool steels usually develop a glass-hard surface zone around a tough core when quenched in water from a suitable hardening temperature; they may be more sensitive to checking (thin sections, sudden change in cross-section) than the usual oil hardening steels. With up to 1.7% C they can be forged, rolled and machined with or without previous annealing. With up to 0.6% C they are malleable and can be pressure-welded. A useful table contains steels of various German manufacturers, their treatments and application. The steels should be heated slowly for forging and cooled moderately slowly, *e.g.* in dry ashes. Forging temperatures vary widely for different brands between 750° and 1100° C. Annealing is accomplished between 650° and 770° C. For hardening, straight quenching in water of 20° C. is usually applied. Sometimes the steel is dipped into water and then into oil, or vice versa. Other quenching media are suggested for a few steels. Hardening from the forging heat is not permissible. Hardening temperatures are closely confined and vary between 740 and 870° C. Plain C tool steels should be tempered immediately after hardening to relieve hardening strains, avoid brittleness and maintain toughness of the core. Tempering temperatures above 320° C. are not used. The correct steel is selected mostly according to the stress on the tool, or its ability to hold cutting edge, or its resistance to wear. The type of machining operation, the material to be machined and its temperature are criteria. The required hardness, sensitivity to overheating, size and shape of the tool also influence selection of a tool steel. RPS (5a)

New Furnace Broadens Use of "Moly" Tools. *Iron Age*, Vol. 142, Dec. 22, 1938, pp. 30-31. Practical description of a new gas-fired heat treating furnace introduced by Surface Combustion Corp. It is claimed to be the first atmospheric furnace that will satisfactorily heat treat Mo tool steels without "soft skinning" or "surface decarburization." The equipment is known as the Char-Mo furnace. The furnace is not restricted to heat treatment of Mo steels, but at heat treating temperatures its atmosphere is non-decarburizing and non-oxidizing for all steels except those of high Cr content. VSP (5a)

Results of Application of Streamlined Form of Bricks in Regenerators of Steel Mill Furnaces. Roman Dawidowski. *Hutnik*, Vol. 10, No. 10, 1938, pp. 507-515. In Polish. Results are given of an inspection of a regenerator in which the checker work is made up of bricks of a newly developed streamlined shape. A saving of 24.5% fuel with an increase in the life span of the brickwork, permitting a corresponding rise of the amount of steel produced per ton checker work from 110.2 to 203.2 tons, is made possible by this innovation. 15 references. JGT (5a)

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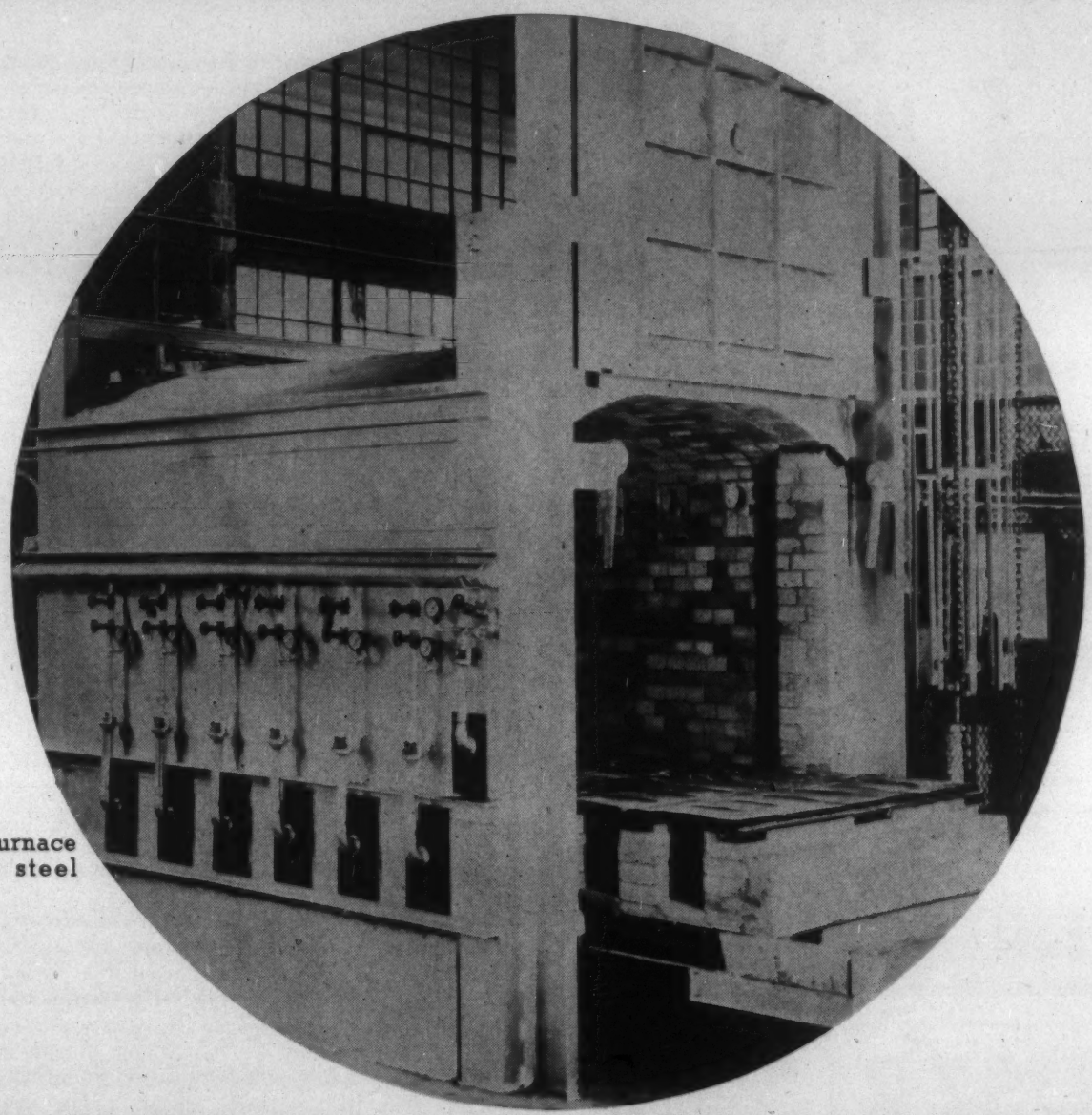

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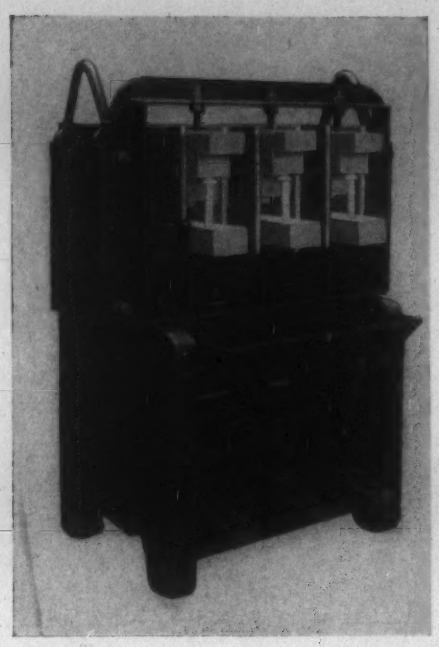

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Impact Torsion Tests of Quenched and Tempered Tool Steels. M. ITIHARA. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Nov. 1938, pp. 552-557. In Japanese. Original research. Impact torsion tests of 3 plain C tool steels were made with a tester having capacity of 30 kg.-m. with initial striking speed of 1,000 rev./min. Two maxima occurred in the C steels that were tempered at 200° C. and 350° C., and 2 minima at 270° C. and 400° C. For these steels, tempering up to the first maximum point is most desirable for tools. NS (5a)

5b. Non-Ferrous

M. H. MAWHINNEY, SECTION EDITOR

The Development of Age-hardening Alloys I. *Light Metals,* Vol. 1, Dec. 1938, pp. 395-400. Comprehensive review. The relationship between constitution and age-hardening is reviewed. Phenomena included in this conception are the usual decreasing solid-solubility with fall in temperature in a terminal solid solution, eutectoidal decomposition, phase changes with falling temperature in intermediate phases, and superstructure. In the case of Mg alloys, for example, age hardening results have been thus far somewhat disappointing. The best age-hardening effects are usually obtained when the separating phase is not a pure metal or terminal solid solution, but a β phase or hard intermetallic compound, as $CuAl_2$ in Al-rich Al-Cu alloys. The temperature level at which age-hardening is produced is also of prime importance in determining the amount of hardening. This may explain the failure of most elements which when added to Pb, for example, fail to produce hardening even when the type of constitution is favorable. Failure for age-hardening to occur when it is expected may be due to other causes than unavoidable over-aging. For example, it is not always possible to retain a solid solution stable at high temperatures by rapid cooling (quenching). In other cases, the alloy approaches equilibrium so slowly that at reasonable aging temperatures, no hardening occurs. Eutectoid transformations cannot always be undercooled, and the quenched alloy may be exceedingly hard. Alloys not exactly of eutectoid composition usually suffer composition changes when cooled from the single phase region to the eutectoid temperature. These composition changes may form the basis of age-hardening. Very frequently the decomposed eutectoid is made up of one or two hard intermediate phases, and if this is the case, the resulting alloy is usually stable and is able to retain its hardness. A valuable addition to this review is a complete list of terminal solid solutions of binary alloys that show decreasing solid solubility with fall in temperature together with age-hardening data, where such exist. AUS (5b)

The Development of Age Hardening Alloys. II. *Light Metals,* Vol. 2, Jan. 1939, pp. 17-22. Comprehensive review. Peritectoid alloys may be hardenable owing to the difference in position of a 2-phase alloy with respect to the 2 bounding solid solutions, above and below the transformation temperature. Order-disorder alloys may be hardenable if the ordered "phase" has a different crystallographic structure in terms of unit cell and symmetry than the original "phase." For example, in the case of AuCu, a tetragonal structure is formed in the ordered, or semi-ordered phase, and the alloy is thus hardened; the $AuCu_3$ superlattice is distinguishable from the unordered lattice solely by the relative positions of the Au and Cu atoms, and no hardening occurs. The hardening of alloys of the AuCu type depends upon undercooling the alloy into an unstable state where ordering proceeds by standing at some suitable low temperature. The heat treatment is entirely analogous to the case of precipitation hardening. Similarly, also, the aging temperature must not be too high, since the end-point of practically complete order may result in a hardness lower than the highest possible hardness. The maximum hardness is usually attained at some intermediate point between complete order and complete disorder. Additions of third or even fourth elements to alloys capable of forming suitable superlattices may result in increased hardness. An example is the addition of Ag to AuCu. As is well known, many of the important age-hardenable alloys of commerce are ternary or even more complex alloys. Two such examples are duraluminum (Al-Cu-Mg) and tempaloy (Cu-Ni-Si). Many ternary age hardenable alloys may be considered as pseudo-binary alloys, such as $Cu\text{-}Ni_2Si$ (tempaloy) mentioned above. Most of these alloys are of the simple precipitation type where the α solid solution has a broader solid solubility range at elevated temperatures than at lower temperatures. On the other hand, age hardening is not necessarily confined to alloys that are homogeneous solid solutions at elevated temperatures; but duplex alloys can often separate a third constituent at lower temperatures, and hence give rise to age hardening. Certain alloys, such as N-bearing Fe and Al-Mg alloys are suitably hardened by merely cooling from the casting temperature, and are not improved by solution quenching. In most cases of precipitation hardening in an unstable solid solution, maximum

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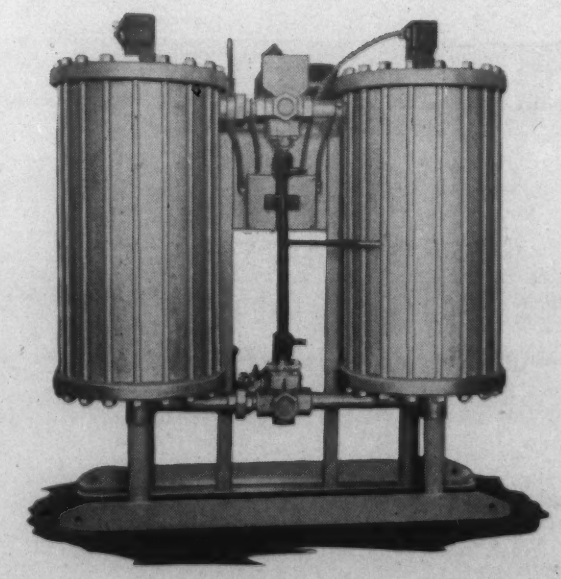

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hardness is usually attained in alloys whose composition lies near or at the solubility limit at the solution-treating temperature; but there are cases where maximum hardness is attained in alloys whose composition lies well within the solid solution field, such as Al-$MgZn_2$, or in the duplex field, an example of which is Cu-rich Cu-Ag. Pb-Sb is an example of an age-hardening system where the addition of small amounts of other elements greatly improves age-hardenability. The pure binary alloy exhibits very little age-hardenability, but the presence of .005% Cu and .05% As allows the hardness to increase from 4.9 to 13 Brinell. Third elements may be added for other reasons than increasing the hardenability. For example, Mn is added to duralumin for improvement of the corrosion resistance. The solution treating temperature should be as low as possible to avoid excessive grain growth. The best temperature for the aging treatment is usually a compromise between that dictated by experimental results and that dictated by economic considerations. Age hardening may be made to proceed more rapidly at higher temperatures, but the maximum hardness is usually reached by relatively long aging times at lower temperatures. Another factor to be considered is possible loss of ductility or corrosion resistance, which is apt to accompany an alloy in the fully-aged or over-aged condition. In development work it is important that the results of various aging times at various aging temperatures be known; otherwise the behavior of the alloy in comparison to other alloys may be very misleading. While hardness and tensile strength are the 2 properties that are most frequently plotted as a function of the changes occurring in an alloy during age hardening, other properties may be important in some applications. Age hardening rarely improves the fatigue strength. Cu-Be is an exception to this, but the accompanying loss in damping capacity is often a detriment to its use in some instances. In the general field of non-ferrous age hardening alloys, some unique attribute or group of properties is necessary to place a new alloy in the field. The development of new alloys in the future will, in general, be concerned with those which exhibit definite superiority over existing alloys for use in some unique or clearly defined application.
AUS (5b)

Some New Solutions for the Heat Treatment of Light Metals in Electric Furnaces (Einige neue Lösungen bei der Wärmebehandlung von Leichtmetallen in Elektroöfen) OTTO GENGENBACH. *Vorträge der Hauptversammlung 1938 der Deutschen Gesellschaft für Metallkunde, V.D.I. Verlag, Berlin,* 1938, pp. 94-96. Original research. Describes and illustrates 9 recently developed German electrical furnaces for heat treatment of light metals. Efficiency of heat transfer by radiation is much smaller than by convection. The heating units are sometimes arranged in a special chamber and the furnace atmosphere always circulated by fans. With the increasing use and size of light metal structures and parts, larger furnaces as described in the paper have been constructed. The trend towards automatic (hydraulic) charging and discharging is apparent. Light metal sheets are subject to warping on quenching in water. An annealing furnace is shown that is directly connected with a "quenching chamber" that can be quickly filled with spray. By using spray or cold air blast warping is avoided.
EF (5b)

The Recrystallization and Softening of Wrought Magnesium Alloys (Ueber die Rekristallisation und Entfestigung der Magnesium-Knetlegierungen) W. BUNGARDT, K. BUNGARDT & E. SCHIEDT. *Metallwirtschaft,* Vol. 17, Dec. 2, 1938, pp. 1267-1272. Research. Recrystallization study of 2 commercial Mg sheet alloys, one (Mg-Al 6) containing 6.40% Al, 0.29% Mn and 0.90% Zn and the other (Mg-Mn) containing 2.02% Mn. Metallographic, X-ray and physical property studies were carried out on alloys cold rolled various amounts and annealed at various temperatures for 30 min. The recrystallization of the Mg-Al 6 alloy cold rolled 6-17% and annealed for 30 min. takes place over a temperature range of 60°-70° C. and is complete at 310° C. The recrystallization temperature range for the Mg-Mn alloy is 220°-290° C. for alloys cold rolled 8-57%. Recrystallization is complete in this alloy at temperatures of from 420° to 450° C. Physical property tests for the Mg-Al 6 alloy cold rolled 3.2, 5.5 and 10% and for the Mg-Mn alloy cold rolled 3.9, 5.6 and 11.2% confirm the X-ray studies.
GA (5b)

Annealing Brittleness of Si-bronzes. S. KURODA. *Nippon Kinozku Gakkai-Si,* Vol. 2, Dec. 1938, pp. 619-628. In Japanese. Original research. Si-"bronzes" (Cu-Zn-Si alloys) develop certain peculiarities on annealing at 300°-500° C.; shock resistance and elongation decrease, hardness increases, and yet tensile strength remains almost the same. Within the above temperature range, the higher the temperature and longer the time of annealing, the more brittle the alloy becomes. This is attributed to precipitation of γ phase in the grain boundaries of α phase by decreasing solubility of Si in the α phase. Attempts to prevent this precipitation by addition of other elements gave little success. The solubility of Si at 250° C. in Cu-Zn alloys was much less than that given in former reports.
NS (5b)

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6·WELDING AND CUTTING

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

Shrinkage Control. G. J. GIBSON (Pittsburgh-Des Moines Steel Co.) *Steel,* Vol. 103, Dec. 5, 1938, pp. 56-57. Practical. Recommendations are given for avoiding or diminishing shrinkage due to welding. Although they apply particularly to butt joints, the same principles pertain to fillet welds. Smallest amount of weld-metal possible and smallest groove permitting desired penetration should be used. Practical limits for field welding are 60° vee with a 3/32-1/8 in. root spacing for complete penetration. Electrodes should be used that require least heat per unit of weld deposited within the limits that produce acceptable weld-metal. High welding currents, large electrode diameter or electrode with high melting speed and small spatter loss will produce most deposited weld-metal per unit time. Never permit piece being welded to cool for a long period unless weld is built up to full plate thickness. Use a partly fixed condition, such as weights on tack welding. Distribute heat over length of long seams by starting at center and welding toward each end, using step-back method. Wherever possible protect parts during or after welding, until they are at room temperature. Weld plates in such thick layers that reverse side assumes a red heat during welding, and use a means of restriction against bending. In general, weld all end connections of plates first and then long seams between. Where transverse joints occur, weld them first and then weld shapes to plate using intermittent fillet welds where possible. Joints causing greatest shrinkage should be welded first, and joints causing least shrinkage welded last. Cold peening is particularly effective in reducing shrinkage stresses when plates are restrained. In unrestrained plates, hot peening immediately after welding is easier and just as effective. Each layer should be peened over its entire surface using rapid, light blows. Blunt-nose peening tool is best. Transverse shrinkage of lap joints is not as important as that of butt joints. Longitudinal shrinkage along joint is much less troublesome. It appears to be a constant of about 0.035% over seam length for butt, lap, and tee joints in plates 3/16-1/2 in. thick. Intermittent welds will produce less shrinkage than continuous welds. Curves showing amount of transverse shrinkage for various types of butt-welded joints and various plate thicknesses, and relative shrinkage of different types of joints are presented. MS (6)

6a. Ferrous

Manufacture and Properties of Thin-walled Welded Pipes of Steels of High Strength (Herstellung und Eigenschaften nahtgeschweisster Rohre aus Stählen höherer Festigkeit) H. CORNELIUS. *Autogene Metallbearbeit.,* Vol. 31, Nov. 15, 1938, pp. 361-364. Descriptive. Tubes of 1 mm. wall thickness can be made of Cr-Mo and Mn steels with welded seams with as satisfactory mechanical properties as seamless tube if, after the oxy-acetylene welding, the seam is annealed so that recrystallization in the weld takes place and the whole pipe is soft-annealed before cold-drawing, to 6-8% greater width. Defective welds develop cracks under such treatment, so that they are rejected in an early stage of the manufacture. Ha (6a)

Using Ni-clad Steel. Part I. F. P. HUSTON (Internatl. Nickel Co. Inc.) & T. T. WATSON (Lukens Steel Co.) *Welding Engr.,* Vol. 23, Dec. 1938, pp. 19-21. Practical. Strength of the Ni-to-steel bond was demonstrated by means of a specially prepared bar so designed that the break at ultimate tensile strength occurred in the steel weld at 50,900 lbs./in.^{2} Material may be gas-cut almost as readily and at about the same speed as steel plate. Joints may be made by welding, the Ni side being welded with Ni welding rod. Corrosion resistance is entirely adequate for the purposes that employ Ni-clad steels. Metallic arc method is generally used. CEJ (6a)

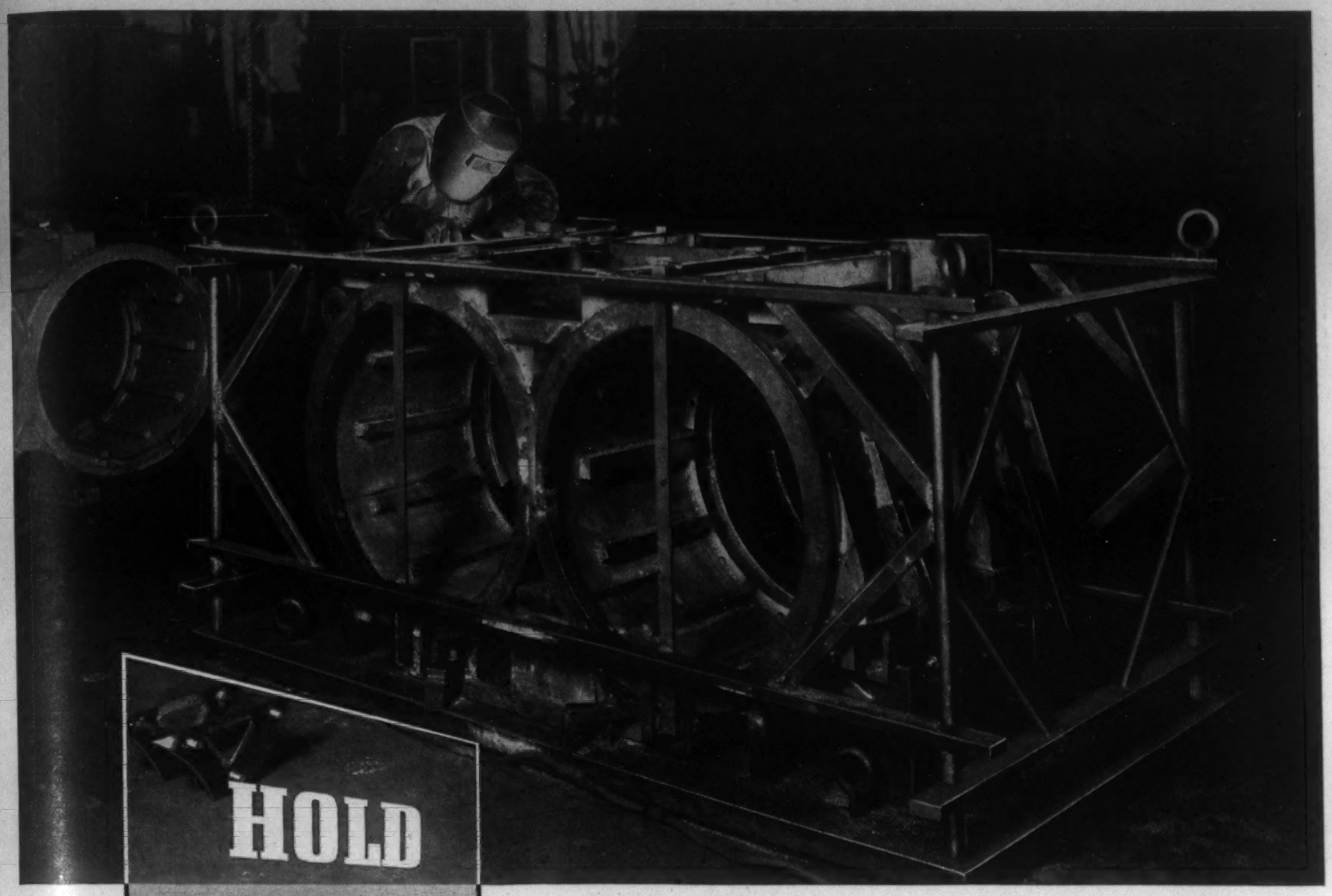
The Fatigue Strength of Oxyacetylene Welded Rails. OTTO GRAF. *Welding J., N. Y.,* Vol. 17, Nov. 1938, Suppl. pp. 29-30. Extended abstract of article in *Autogene Metallbearbeit.* See *Metals and Alloys,* Vol. 10, Jan. 1939, p. MA 47L/5. CEJ (6a)

Low-alloy Welding Steels. HOWARD STARK. *Ind. & Welding,* Vol. 2, Dec. 1938, pp. 44-45. Review. The physical properties of low-alloy high tensile steels are considerably better than those of mild steel, and yet do not materially affect the forming operations. Practically all the steel manufacturers are producing some form of these new materials, and the various analyses that are being marketed are as varied as the makers. Some are dependent upon small additions of Cr for the increased strength, others upon Mn, Si, Ni, Cu, and combinations of these. Welding electrodes of comparable analyses can be secured for use with any of these new steels, and many of these materials have better welding characteristics than either flange or firebox steel. It can be only a matter of time until industry will use the low alloy steels to a very great extent. CEJ (6a)

6b. Non-Ferrous

Progress in Copper Welding. I. T. HOOK & C. E. SWIFT (Am. Brass Co.) *Welding J. N. Y.,* Vol. 17, Oct. 1938, Suppl. pp. 48-60. A report of a research survey of weldability of known alloys and welding rods under conditions of welding similar to service. A brief historical review of evolution of Cu welding is made, and a detailed account is given of the research program for evaluating (a) relative melting point, (b) strength, (c) ductility, (d) soundness, (e) flowing properties and (f) general properties (color match, grain size, hardness, corrosion resistance and fatigue resistance). Tabulated results are given for all the welds tested, made by the oxyacetylene and C-arc method. General conclusions are: (1) In any method of welding, better weld strength and ductility are obtained in deoxidized Cu base metal than in tough-pitch or electrolytic Cu base metal. This is true whether the base metal is deoxidized with P or with Si. (2) The Si-deoxidized Cu base metal shows better hot ductility than the P-deoxidized Cu. (3) In the welding rod for gas welding, the P should be low, of the order of 0.03%, while in an arc-welding rod, 0.08% is insufficient. On the other hand, 0.25% P makes a satisfactory arc-welding rod. If Si is used as the deoxidizer or strengthening agent in the welding rod, 0.06% is too low for arc welding and is also slightly low for insuring soundness in gas welding. (4) With either gas or arc welding, the M rod having 3% Si, 1% Mn and the remainder Cu, shows close to the maximum results in both strength and ductility. The L rod, high in both Sn and P, gives results as good as those of the M rod in arc welds, but is unsatisfactory for gas welds. (5) In general, the arc welds show a higher strength in electrolytic Cu base metal than do the gas welds. By and large, the gas welds can be depended upon for an efficiency of only 60%, while the arc welds should develop 80%. (6) The P-containing rods should be melted with a long arc, while the Si-containing rods are preferably melted with a short arc. (7) The P-containing rods can be applied only in the flat or nearly flat position, while the Si-containing rods can be used to a limited degree in position welding. WB (6b)

Welding of Non-ferrous Metals with Butane-oxygen (Schweissen von Nichteisenmetallen mit Butan-Sauerstoff) V. THÜRNAU. *Autogene Metallbearbeit.,* Vol. 31, Nov. 15, 1938, pp. 364-367. Descriptive. Non-ferrous metals, except hydronalium, can be successfully welded with a mixture of butane and O. The width of the weld is less for butane than for acetylene, so that the wire consumption is lower, but although butane is cheaper than acetylene, oxyacetylene welding is cheaper as the welding speed for the latter is higher. No neutral flame exists for butane as for acetylene. The low flame temperature makes the oxybutane flame unsuitable for welding of Fe sheets. The flame will be used with advantage only in such cases where (as in welding of foils) city gas or H had previously been used. Experiments with different metals are described in detail, as well as the arrangement of burners and mixtures. Ha (6b)



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7·FINISHING

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H. S. RAWDON, SECTION EDITOR

The Development of Metal Coating Technique in 1937 as Reviewed in the German Patent Literature (Die Entwicklung der Metallüberzugstechnik im Jahre 1927 an Hand der deutschen Patentliteratur) K. NISCHK. *Oberflächentech,* Vol. 15, Dec. 6, 1938, pp. 233-236; Dec. 20, 1938, pp. 247-249. German patents for cleaning, degreasing, polishing, pickling of metals, electroplating, and protective films by anodic treatment, and for hot-dipping in molten metals are reviewed, and some applications described in detail. A pure Au layer on a Au alloy is, according to DRP 644,602, produced not by electrodeposition or hot-gilding, but by anodic treatment for 2-3 min. in a solution of 2% HNO_3; the alloying constituents are removed from the surface metal, and the piece is then rinsed in distilled water and polished. Ha (7)

7a. Electrolytic Methods

Control of Plating Solutions. *Electrical Rev.,* Vol. 123, Oct. 21, 1938, pp. 575-577. Practical. Describes methods of and equipment for filtration, agitation, heating and testing. Continuous filtration is necessary for agitated solutions, particularly warm Ni-plating solutions. Agitating and filtering apparatus are now combined in new installations. Filter unit consists of vitreous enameled filter pots carrying 7 or 10 filter "candles" made of kieselguhr. Candles are mounted on a plate or grid that can be easily withdrawn. Air-circulating pump and a motor-driven air-valve are used. Another type is a self-contained motor-driven portable unit, in which filter pots, motor, pump, and suction and delivery hose are mounted on a trolley for placing alongside vat. This is used in conjunction with a storage vat that is mounted on a raised platform. Efficient method for average-size warm Ni-plating plant is a cone-type filter unit mounted at opposite corners of plating tank, with agitation effected by rotary air-pump taking air from a container and discharging it from jets through coils in bottom of tank. Heating coils are placed alongside. For automatic plants, filter pots with kieselguhr candles or special filter-presses may be used. In both cases, solid Ni motor-driven pumps and storage tanks are employed. Most common form of electric heating is a cable laid on floor of tank. This is suitable for warm Ni, acid Cu, Zn and all acid plating solutions. For Cr baths, electric ring units are used. Cyanide and alkaline solutions are heated by an immersion heater. Acidity of Ni solution can be measured by means of comparators of colored glass or paper. Salt-spray method is the most reliable for testing corrosion resistance of plated articles. Paper coated with ferroxyl indicator affords a quick test for porosity in small plants. Test sets are available for controlling free cyanide in Cu, Ag, Au, Cd and brass solutions; free acid in acid Cu solutions; free KOH in Sn baths; metallic content of Cd solutions; and thickness of Cd deposit. Free KCN in a $Cu(Cn)_2$ bath should be maintained at about 1½ oz./gal. Good free cyanide for a hot brass solution is 1½-1¾ oz./gal. and for a cold solution, 2¼-2½ oz./gal. MS (7a)

Rochelle Salt Cyanide Copper Baths. R. M. WAGNER & M. M. BECKWITH. *Proc. Am. Electroplaters' Soc.,* June 1938, pp. 147-163. Original research. The effect of variation of bath composition and operating conditions on cathode and anode current efficiency was studied. The determination of free cyanide by $AgNO_3$ titration was found to be influenced by the conditions of titration. A high CuCN concentration in the bath is favorable as it increases anode and cathode efficiency. The NaOH concentration should be 0.05-0.5 oz./gal.; if higher, anode efficiency decreases, although cathode efficiency is not affected. Free NaCN should be about 0.75 oz./gal.; higher concentrations do not materially increase anode efficiency but considerably decrease the cathode efficiency. The Rochelle salt concentration does not appreciably affect the cathode efficiency; 2-4 oz./gal. is the best for optimum anode corrosion. The Na_2CO_3 content should be low, about 2 oz./gal. Higher amounts decrease anode and cathode efficiencies. Carbonate can be decreased by adding tartaric acid, which liberates CO_2. Anode and cathode efficiencies decrease with increase of current density. Both increase with the temperature, but there is little gain above 150° F., and the loss of cyanide is greater. Fe in the bath reduces anode efficiency and should not exceed 0.75 g./l. As little as 0.1 g./l. of Cr as chromate will stop deposition. AB (7a)

Wetting Agents in Nickel Plating Solutions. NEWARK BRANCH OF THE A. E. S. *Proc. Am. Electroplaters' Soc.,* June 1938, pp. 225-235. Practical. Wetting agents are added to prevent pitting of deposits by H bubbles. The wetting agents are sodium alkyl sulphates, alkyl naphthalene sulphonates, fatty acid amides, etc. They prevent pitting by lowering the surface tension of the liquid so that gas bubbles can not cling to the plated surface and are more economical than H_2O_2 for stopping pitting as they do not rapidly decompose. Wetting agents should be soluble; if they precipitate, they produce poor Ni deposits. Their concentration is maintained in accordance with surface tension measurements. Surface tension at first decreases with increasing concentration of wetting agent but, after a certain concentration is reached, becomes constant. Addition of agent beyond this concentration is uneconomical and may also cause pitting. The surface tension of a solution should be below 37 dynes/cm. to prevent pitting. Oil, soap and foreign matter must be kept out of the tanks as they will be emulsified by the agent and produce inferior Ni deposits. Wetting agents can be removed from a bath with $KMnO_4$, followed by an increase in the pH, then by a treatment with activated clay and activated C, and filtering. AB (7a)

A Study of Cyanide Copper Plating Baths. C. B. F. YOUNG & GERALD REID. *Metal Ind., N. Y.,* Vol. 36, Dec. 1938, pp. 560-562. Effects of variations in pH, temperature, current density and concentration in copper cyanide solutions were studied. The following formula is recommended: CuCN 12 oz./gal., NaCN 14 oz./gal., Na_2CO_3 10.5 oz./gal., temperature 70° F., current density up to 20 amps./ft.², anode efficiency 75%, cathode efficiency 91% and pH 11 (determined by paper strip). CBJ (7a)

7b. Non-Electrolytic Methods

The Effect of an Addition of Aluminum on the Formation of Hot-galvanized Coatings (Der Einfluss des Aluminium-Zusatzes auf die Ausbildung des feuerverzinkten Übersuges) H. BABLIK & F. GÖTZL. *Korrosion u. Metallschutz,* Vol. 14, Oct./Nov. 1938, pp. 350-353. Original. The Fe loss and Zn absorption of low-C steel in Al-containing Zn baths were investigated, with the following results:

Time of Immersion min.	Fe Loss, g./dm.² Al content of bath, % 0.025	0.05	0.10	0.15	0.20
1	...	0.16	0.16	0.15	0.06
2	0.26	0.20	0.22	0.22	0.10
4	0.28	0.26	0.34	0.37	0.21
8	0.39	0.34	0.35	0.62	0.45
15	0.46	0.50	0.50	0.98	0.96
30	0.67	0.67	0.75	1.18	1.48
60	0.92	0.93	1.21	1.57	1.66

Time of Immersion min.	Zn Absorption, g./dm.² Al content of bath, % 0.025	0.05	0.10	0.15	0.20
1	...	3.61	3.41	3.49	2.54
2	5.82	4.32	4.57	4.63	1.59
4	5.86	6.22	6.98	7.08	5.24
8	7.95	6.67	6.86	12.60	9.58
15	8.68	8.80	8.95	22.68	20.5
30	11.77	11.27	12.48	15.85	22.6
60	12.81	12.80	18.30	15.92	18.7

With quick immersion, increase of Al content results in lower attack; with long immersions, increase of Al results in increased attack. Micrographs are included. Ha (7b)

The Application of Polishing and Buffing Wheels. ROBERT T. KENT. *Metal Cleaning Finishing,* Vol. 10, Nov. 1938, pp. 762-775. Descriptive. A discussion of automatic and semi-automatic polishing and buffing machines. Hand lathes for heavy duty should have an arbor 1.5 in. or more in diameter. Variable speed is desirable, so that the correct surface speed can be obtained with buffs of different sizes. There are 3 types of automatic or semi-automatic machines: (1) Straight-line machines; (2) multiple-head machines; (3) contour machines. Their general principles of design are discussed. The straight-line machine consists of a series of wheels that float on the work with a predetermined pressure, the work being carried under the wheels on a conveyor chain. Small pieces are loaded on a work fixture that may be locked onto the conveyor while the latter is in motion. The multiple-head machine consists of a head that carries a number of chucks for holding the work. The head in rotating brings each piece of work into contact with a wheel for a predetermined time. The chuck may rotate and bring all sides of the object into contact with the wheel. Several wheels can be used so that cutting down and coloring can be done at the same time. Contour machines are used to finish work of non-circular cross-section. The work is rotated and at the same time kept in contact with the wheel by a cam arrangement. AB (7b)

Wear Resistance. W. H. SPENCER (Sealed Power Corp.) *Steel,* Vol. 103, Dec. 5, 1938, pp. 60-62. Industrial note. Describes the "Granosealing" process for phosphate treatment of Fe and steel wearing surfaces to prevent scuffing. The surface to be treated is put into a cleaning solution at 140° F. and rinsed in H_2O at same temperature. Ordinary Fe and steel parts are then placed in a treatment bath. Hardened steel or chilled Fe are preferably etched in acid before being treated. Bath consists of dilute H_3PO_4 containing Mn and saturated with Fe. Careful control of concentration of the solution is not important. Treatment period (indicated by cessation of gas evolution) ranges 5-30 min., depending on composition of metal, and strength and temperature of solution. For piston-rings, solution contains about 2% free acid, the temperature is 210° F., and immersion time is about 10 min. Parts are then washed in 140° F. H_2O and dipped into a soluble oil solution. Thickness of coating can be varied by changing methods of application. Minimum thickness ordinarily used is about 0.00025 in. The surface retains oil and rubs down, to produce a polish with a metallic appearing finish. The treatment is not claimed to prevent scoring due to faulty cooling of engine or to distortion of cylinder; it does, however, prevent scuffing in new engines during wearing-in period. Where scuffing conditions are not present, it reduces amount of wear. MS (7b)

Corrosion Protection of Aluminum-magnesium Alloys by Cladding (Korrosionschutz von Aluminium-Magnesium Legierungen durch Plattieren) P. BRENNER. *Metallwirtschaft,* Vol. 17, Dec. 2, 1938, pp. 1272-1276. Original research. Investigation of cladding as a means of combatting intercrystalline corrosion in Al-Mg alloys containing considerable Mg (7-8%). If pure Al is used as a protective covering, severe attack will take place at the unprotected regions. High Mg alloys were successfully protected with an Al alloy coating containing 5% Mg. This latter alloy is not susceptible to intercrystalline corrosion. Cladding with an alloy of lower Mg content alloy reduces the potential between core and cover plate and lessens corrosion at cut edges. The same effect can be obtained by cladding with a thin Al layer and then diffusing Mg out of the core by annealing. Al-Mg clad material containing about 1% Zn assists materially in reducing corrosion, with the retention of tensile strength. GA (7b)

Welding of Magnesium Alloys (Schweissen von Magnesiumlegierungen) P. BRÄUER & O. LEHMANN. *Autogene Metallbearbeit.,* Vol. 31, Dec. 15, 1938, pp. 398-401. Practical. The proper procedures for welding Mg alloys, whether rolled, forged, cast or die-cast, are discussed at length. All Mg alloys can be satisfactorily welded if the proper flux is employed, which dissolves the oxide layer protecting the metal and prevents the burning of the edges; several commercial types are described. The welding rod should always be of the same material as the basis metal. The torches used for Al can also be used for Mg welding, but with a slight excess of acetylene. The spots to be welded must be well cleaned; castings should be heated after welding to 350° C., slowly cooled in the furnace, and the flux residue washed off with warm water. If, despite all care, a piece should start to burn, sand and gray Fe scrap should be used for extinction—but no water. Many examples are given. Ha (7b)

Hints on Silvering Glass. F. E. J. OCKENDEN. *J. Sci. Instruments,* Vol. 15, June 1938, pp. 206-208. Detailed description of the silvering of glass with the well known Edel formula, comprising silver nitrate and potassium sodium tartrate. Soap is recommended for cleaning, since caustic soda or strong alkalies may result in fogging. Oxidation of the deposit is prevented by using special care in mixing and boiling to remove dissolved O. A bluish white fog indicates tap water contamination. RAW (7b)

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8·TESTING AND CONTROL

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

Radiography and X-ray Crystallography in Industry. F. BRECH (Adam Hilger) *Light Metals,* Vol. 2, Jan. 1939, pp. 27-30. Review. X-ray diffraction is gradually assuming its place in modern metallurgical industry for testing metallurgical products and processes. Some problems that may be solved by its use are as follows: (1) Determination of crystal structure; (2) identification and analysis of phases present in an alloy; (3) examination for the presence of surface deposits, scale and other surface phenomena, and of the physical and chemical properties of such deposits; (4) determination of grain size; (5) determination of the effects of changes of crystal grain orientation produced by rolling, drawing and extrusion; (6) detection of effects due to hot and cold work; (7) detection and analysis of regular and irregular strains on either side of the yield point; (8) investigations of strain release resulting from heat treatment; (9) chemical analysis. The use of the X-ray diffraction method in the problems listed above is briefly described, and several typical photograms are shown that clearly illustrate the effect of cold work, heat treatment, etc. on the diffraction lines. [While this paper describes no new methods or techniques, and hence is more or less wasted on the technically trained metallurgist, it should be required reading for executives who pass on purchases of equipment and who have not yet heard of the industrial possibilities of X-ray diffraction. A.U.S.] AUS (R-8)

Graphic Determinations of the Characteristic Bend Curve of Constant Cross Section Shapes in the Elastic-plastic Region (Zeichnerische Ermittlung der Biege-Kennliniebeliebiger Querschnittsformen im federnd-bildsamen Bereich) ST. SZTATECSNY. *Metallwirthschaft,* Vol. 17, Oct. 21, 1938, pp. 1101-1104. Theory and comparison with experimental results. The formula $M_1 = \Theta a . E . W$ describes the bend curve in the elastic region. M_1 is the bending moment, Θa the elongation in the outermost fibers, E the modulus of elasticity and W the section modulus of the whole cross section. Another formula $\frac{M_2}{M_s} = 1/W . [W^1 + F'' . Z_s]$ is derived to describe bending of a section of constant cross section in the elastic plastic range. M_2 is the bending moment at any time in the elastic plastic range, M_s the bending moment corresponding to yielding in the outermost fibers, W the section modulus of the whole cross section (W^1 the section modulus of the elastically deformed cross section), F'' the area of the plastically deformed cross section, and Z_s the distance between the neutral axis and the center of gravity of the elastically deformed region. A graphic method for determining this curve for shapes difficult to calculate is set up. The theoretically derived curve coincides well with actual data from bend tests. GA (T-8)

Examination of Welds by Magnetic Testing Methods (Untersuchung von Schweissnähten mittels der magnetischen Werkstoffprüfung) J. STAEBLER. *Autogene Metallbearbeit.,* Vol. 31, Dec. 15, 1938, pp. 393-398. Deviations in the normal magnetic arrangement of Fe filings give a more sensitive test for defects in magnetic materials than even X- or γ-ray methods. Principles of methods and apparatus, and their application, are described in detail, and illustrated by examples. Instead of dry Fe filings, so-called metal oil is now generally applied, which permits the Fe filings to arrange themselves much easier in the magnetic lines. The oil consists of a suspension of finest Fe powder (gray carbonyl Fe powder or black Fe_3O_4) in a suitable oil. Ha (R-8)

An Apparatus for the Direct Indication of Damping Capacity (Ein Gerat zur unmittelbaren Dämpfungsanzeige) F. FÖRSTER & H. BREITFELD. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 343-345. Experimental. A self-exciting vacuum tube circuit is described by means of which damping capacities can be determined at 4-sec. intervals. Applications of this equipment during stress and recovery of an Al rod, during the cooling of a stressed steel rod, and during the accelerated elongation of an Al rod are described briefly. GD (T-8)

The Present Status of Spectrographic Analysis, Especially that of Metals (Der heutige Stand der Spektralanalyse, insonderkeit von metallischen Proben) WALTER GERLACH. *Metallwirtschaft,* Vol. 17, Nov. 18, 1938, pp. 1217-1222. Review. A general survey of the methods and applications, especially as practised in Germany, of qualitative and quantitative spectrochemical analysis of metals and alloys is given. For general qualitative analysis, the author's interrupted arc spectral source is recommended. Two recent modifications of this source, developed by Van Calker (see *Metals and Alloys,* Vol. 9, June 1938, p. MA 372 R/7) and by Pfeilstricker, are described. The possibility of analysis for P, S and the halogens is discussed. For the quantitative analysis of metallic alloys, the use of the Feussner condensed spark and of microphotometric measurements of spectral line blackenings, as described in numerous previous publications, are recommended. A good description is given of the well-known pre-spark effect and of its possible causes. J. S. Owens (H-8)

The Effect of the Speed of Stretching and the Rate of Loading on the Wielding of Mild Steel. E. A. DAVIS (Westinghouse Elec. & Mfg. Co.) *J. Applied Mechanics, A.S.M.E.,* Vol. 5, Dec. 1938, pp. A137-A140. Research. The behavior of mild steel during the first stages of yielding is influenced by stress concentration and speed of deformation. Local yielding produces a condition equivalent to stress concentration at the boundary of the yielded portion which, in turn, causes a rapid strain rate that allows the load to drop in an ordinary testing machine. The conditions under which upper and lower yield points appear are investigated thoroughly; the lower yield point is the load at which the strain rate produced by the high stress developed due to local yielding becomes equal to the strain rate prescribed by the testing machine. 12 references. Ha (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Experiments to Increase the Torsion-fatigue Resistance of Shafts with Transverse Holes by Means of Cold Working (Versuche zer Steigerung der Verdrehdauerhaltbarkeit quergebohrter Wellen durch Kaltverformung) A. THUM & H. WEISS. *Automobiltech. Z.,* Vol. 41, Dec. 25, 1938, pp. 629-633. Original research. The materials used for specimens were Cr-Ni-W-steel and Cr-Ni-Mo-V-steel, both hard or tempered. The specimens were of 60 mm. diameter; with a 5 mm. transverse hole. The change in cross section by holes is taken into account when computing stress, but not the deformation by cold working. Endurance was determined by Wöhler's method with an ultimate number of 10×10^6 cycles. In preparing the specimens, the same changes in shape as effected by cold working were reproduced by machining to indicate what changes in results were actually due to cold work rather than merely change in shape. Experiments with flat punches used to press the shaft in the neighborhood of the transverse hole showed that an increase in endurance could be obtained. Cracks occurred at a stress below the fatigue limit of the untreated material, leading to failure only at higher stresses. The effect of the cold deformation does not relax, as determined by a test with 100×10^6 cycles. The cracks started at an angle of 45° to the axis. At the point where the edge of the punch had acted they stopped and, when the stress was increased, continued at 90° to the first direction. The fracture frequently occurred close to the boring, its location depending upon the pressure applied. The maximum endurance was found at a cold-working pressure that

caused the fracture to start at the edge of the hole itself. If the pressure is increased further, the endurance drops and may fall below the value of untreated specimens. According to the crack phenomena observed, a special punch shape was developed that presses the material in the direction of 45° to the axis and avoids overstressing in the other directions. With this tool the cold working of the hole-edges increased the fatigue strength markedly. Pressures of 28-30 tons were applied. The material is pressed up into pads around the boring. The fatigue resistance was increased when turning the specimens down to the original diameter. Very little scatter of the test result is noted, which indicates that the notch-effect is counteracted in a proper manner. By proper cold-deformation of the boring edge the fatigue resistance could be increased 28-63%. In all cases a fatigue limit of 80% of that of plain specimens could be obtained with the bored shafts.

RPS (8a)

The Effect of Permanent and Intermittent Acting Oscillating Over Loads on the Development of the Fatigue Fracture (Der Einfluss dauernd und unterbrochen wirkender, schwingender Überbeanspruchung auf die Entwicklung des Dauerbruchs) HELMUT MÜLLER-STOCK. *Mitt. Kohle u. Eisenforsch,* Vol. 2, No. 2, 1938, pp. 83-107. Original research. In studying the effect of alternating peak stresses on the fatigue limit, it is important to study the development of a fatigue fracture with uniformly oscillating load. The experiments were carried out on a Schenck endurance bending machine with a rotating sample of St. 37 with 0.06% C, 0.01% Si, 0.50% Mn, 0.025% P, 0.025% S and 0.09% Cu. The fatigue limit was 31,000 lbs./in.^{2} Upon loading a test specimen above its fatigue limit, a temporary improvement of material is first observed, *i.e.* when a sample is preloaded for a short time, and then subsequently subjected to a certain higher relative load, it sustains a higher number of oscillations till fracture than when only tested with the higher load. When the preload lasts a long time, the number of oscillations endured decreases upon second loading. The change of this duration is represented by an S-shaped damage curve. The material improvement first observed is followed by a steep ascent of damage. Shortly before fracture, the damage increases less rapidly. The retardation of the damage occurrence could not be explained. The more the oscillating load increases, the more the damage curve approaches the straight line supposed for the relatively higher load. Simultaneously, the number of oscillations during which a transitory material improvement is observed decreases. The fatigue limit of a material impaired by pre-allied oscillations does not decrease in a straight course with increasing damage, but does so relatively slowly at first, and rapidly later. However, a material impaired by overloads still possesses a fatigue limit, provided the damage was not too large. Experiments with oscillating loads alternating above and below fatigue limit gave the same type of results as when tested only above the fatigue limit. A few tests on structural steel St. 52 and a Si-Mn spring steel proved the results on St. 37 also to hold true in principle for these steels. 14 references. [These results are in harmony with those obtained by Kommers, see *Metals and Alloys,* Vol. 9, No. 10, Oct. 1938, p. MA 616 R/3.—H. F. M.] GN (8a)

Simultaneous Effects of Corrosion and Abrupt Changes in Section on the Fatigue Strength of Steel. T. J. DOLAN (Univ. Ill.) *J. Applied Mechanics, ASME,* Vol. 5, Dec. 1938, pp. A141-A148. Original research. Experiments were made to determine whether the weakening effects of a stress raiser and of corrosion during repeated stress are additive. Fatigue tests in reversed flexure and in reversed torsion were carried out on SAE 3140 steel hot-rolled, quenched and tempered. The following results were obtained:

Treatment	Type of stress	Stress raiser	Endurance limit, lbs. per sq. in. In Air	Endurance limit, lbs. per sq. in. In stream of water	Stress concentration factor: Due to stress raiser	Stress concentration factor: Due to stress raiser + corrosion
Hot-rolled	Reversed torsion	None	44,000	32,500	1.00	1.35
		Fillet	28,000	30,000	1.57	1.47*
		Hole	22,000	13,500	2.00	3.26
	Reversed flexure	None	64,000	34,000	1.00	1.88
		Fillet	36,000	19,000	1.78	3.37
		Hole	31,000	16,000	2.06	4.00
Quench and temper	Reversed torsion	None	56,000	32,500	1.00	1.72
		Hole	30,000	20,000	1.87	2.80
	Reversed flexure	None	90,000	13,000	1.00	6.92
		Fillet	36,000	11,000	2.50	8.18
		Hole	31,000	9,000	2.90	10.00

* Endurance limit in water actually slightly higher than that in air.

Fillet radius was approximately 0.02 in. and diameter of filleted specimens approximately 0.300 in.; the holes were approximately 0.04 in. diameter, and diameter of holed specimens approximately 0.400 in. The reduction of fatigue strength contributed by the corrosion in excess of that caused by the stress raiser varied greatly with heat treatment. For the steel tested corrosion-fatigue causes a much greater reduction in strength under cycles of reversed flexural stress than it does under cycles of reversed torsional stress.

Ha + HFM (8a)

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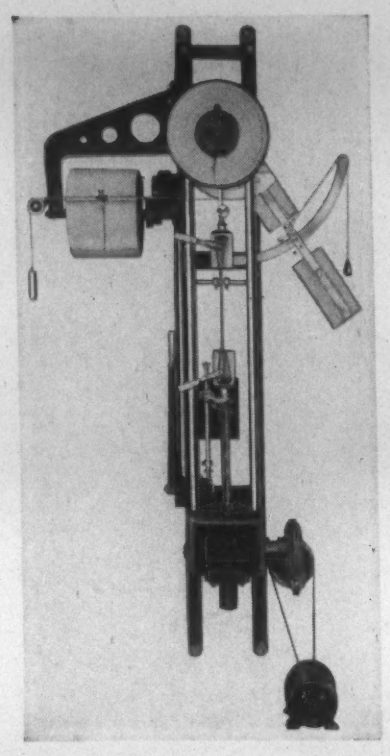

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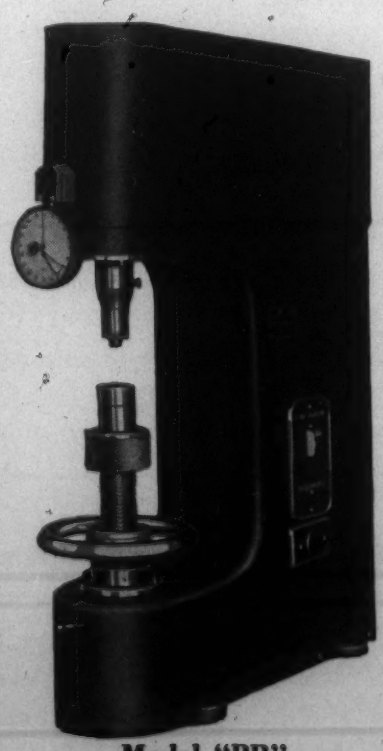

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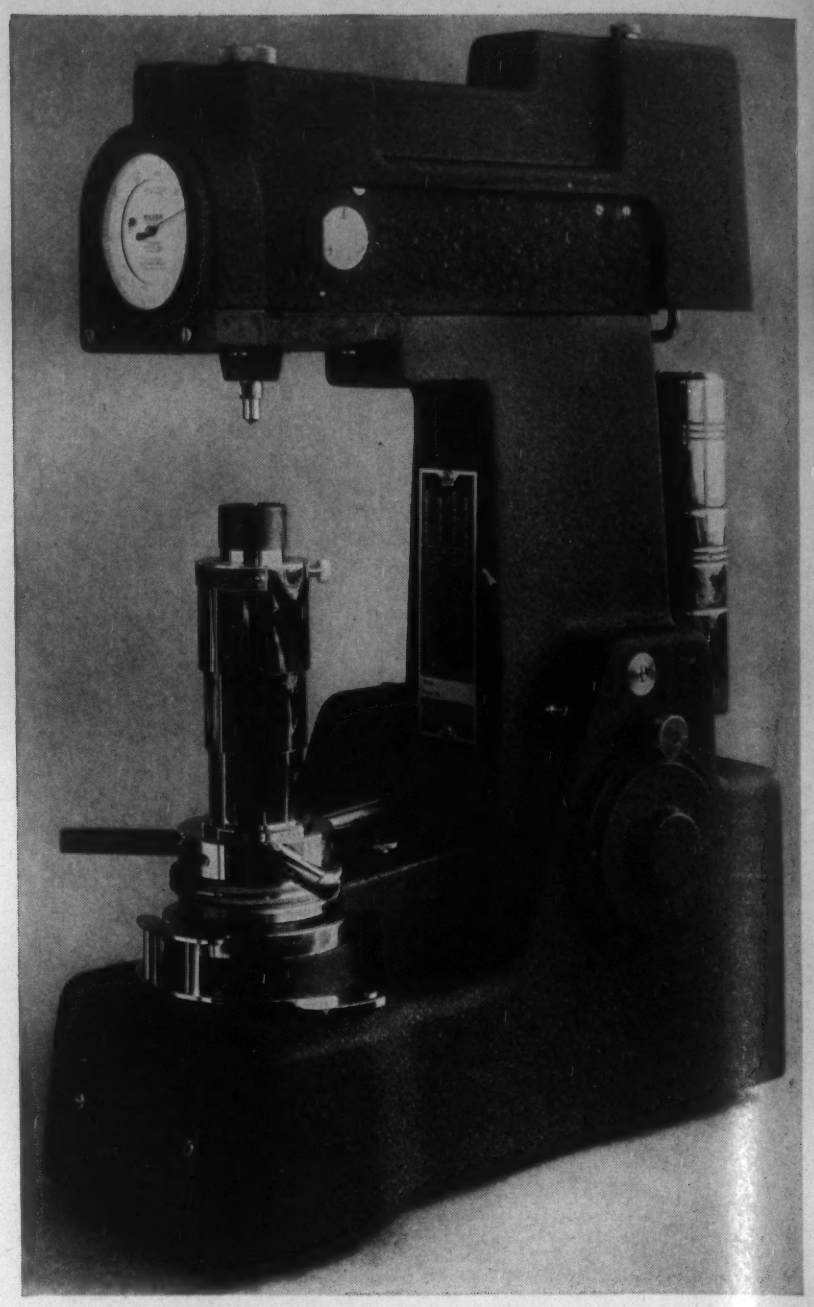

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9·METALLOGRAPHY

Structure and Constitution. Metallographic Equipment.

J. S. MARSH, SECTION EDITOR

The Nature of Polish. G. I. FINCH. *Trans. Faraday Soc.*, Vol. 33, 1937, pp. 425-430. Original. The fact that polished metal surfaces yield halo patterns by electron diffraction does not show whether the surface layer is amorphous or crystalline, because not only amorphous but also certain crystalline metal films behave similarly. The ability of polished films to dissolve metal crystals supports the view of the amorphous state of both surface flow and polish. Polishing results in the flow of calcite single crystal surfaces. The polished layer is crystalline and integral in structure with the underlying crystal when the surface is a cleavage plane or is close in its direction to that of a cleavage plane, but halo patterns are obtained when the polished surface is steeply inclined to all cleavage planes. Heating leads to the gradual emergence of a single crystal pattern through the eventual replacement of the halo pattern. Surface flow is one of vitreous or liquid-like material, and the crystalline structure of the polished layer on the calcite cleavage plane is due to recrystallization of such fluid material under the influence of the underlying substrate crystal. 15 references. PRK (9)

Plasticity and Mosaic Structure of Crystals (Plastizität und Mosaikstruktur der Kristalle) A. KOCHENDÖRFER. *Z. Metallkunde*, Vol. 30, Sept. 1938, pp. 299-305. Theoretical. The atomic mechanisms relating translation in crystals to discontinuities in the lattice are reviewed. From energy considerations it is deduced that the separation, L, of these discontinuities is 8.5×10^{-5} cm. in recrystallized Al, in good agreement with the value of 5×10^{-5} cm. proposed by G. I. Taylor. If L is sufficiently small, no plastic deformation should occur below the critical shear stress, but for large values of L, deformation should occur at much lower stresses. During rapid deformation, critical shear stress and work hardening are not sensitive to changes of L. From this reasoning it is concluded that the discontinuities are located on the mosaic boundaries of the lattice. GD (9)

A Relation between the Heat of Fusion of Intermetallic Compounds and their Melting Points and the Calculation of Heats of Formation of Solution (Ueber eine Beziehung der Schmelzwärmen intermetallischer Verbindungen zu den Schmelztemperaturen und über die Berechnung der Bildungs-bzw. Mischungswärmen) O. KUBASCHEWSKI & F. WEIBKE. *Z. Metallkunde*, Vol. 30, Sept. 1938, pp. 325-326. Theoretical. Known experimental data are used to demonstrate that a proportionality, similar to Trouton's Rule, exists between the heat of fusion and the absolute melting point of intermetallic compounds. This relation is expressed by the equation: Heat of formation $[_{AmBn}]$ — Heat of Solution $[_{AmBn}]$ = 3.5 Absolute Melting Point $[_{AmBn}]$ — (Heat of Fusion mA + Heat of Fusion nB). GD (9)

Automatic Polishing of Metallurgical Specimens Using Cast Iron and Lead Laps. TRACY C. JARRETT (Am. Optical Co.) *Am. Soc. Metals*, Preprint No. 23, 1938, 9 pp. Describes method of automatic polishing of metallurgical specimens. The following sequence of laps and abrasives is recommended: (1) American Optical Co. M303 abrasive on cast Fe lap, (2) M305 on cast Fe lap, (3) 3 successively finer grades of alumina on Pb laps. The abrasives are applied as a paste with kerosene, desulphurized with Hg. The laps are lubricated with kerosene. Apparatus for the levigation of alumina is illustrated. Regular bakelite is employed for mounting. Specimens prepared by this method are flat and free from metal flow. Inclusions are retained HLW (9)

On the Decrease in Mechanical Compressibility of Metals by Alloy Formation (Ueber die Abnahme der mechanischen Kompressibilität der Metalle bei ber Legierungsbildung) F. WEIBKE. *Z. Metallkunde*, Vol. 30, Sept. 1938, pp. 322-324. Theoretical. Tables are given to show that alloy formation is generally associated with a decrease in compressibility and atomic volume, as compared to that determined from the rule of mixtures. By the precepts of spatial chemistry this decrease occurs largely at the cost of the least noble element in the alloy. When there is little difference between the metals, the rule of mixtures applies. GD (9)

A Method of Preparation of Metallographic Specimens. GEORGE A. ELLINGER & JOSEPH S. ACKEN (Natl. Bur. Standards) *Am. Soc. Metals*, Preprint No. 22, 1938, 15 pp. A method for lapping metallographic specimens in use at the Natl. Bur. Standards is described. Two Pb-Sn (50-50) disks charged with American Optical Co. grades 302 and 303½ emery are employed. These disks are machined flat and contain 1/32 in. grooves ¼ in. apart. They are charged by rotating face down on a cast Fe plate covered with a water-emery mixture. The Fe plate is ground on a precision surface grinder and is grooved. Excess emery not embedded in the alloy disk is removed by brushing prior to use. Advantages of the method are: Rapidity, freedom from surface flow and retention of inclusions. The procedure is of particular value in the preparation of specimens of soft metals. HLW (9)

Electric Conductivity and Structure of Thin Evaporated Metal Films (Elektrishe Leitfähigkeit und Struktur dünner, aufgedampter Metallschichten) L. RIEDEL. *Metallwirtschaft*, Vol. 17, Oct. 21, 1938, pp. 1105-1111; Oct. 28, 1938, pp. 1134-1141. Correlated abstract. Theory and experimental data are reviewed. The J. J. Thomson theory that the specific resistance is not a material constant but a function of the average free path of the electrons and the film thickness is sufficient to explain the relationship between specific resistance and the thickness of the film as long as the film is viewed as being crystalline. The strong influence of included gases on conductivity explains the high specific resistance of thick films as well as the irreversible resistance change upon heating of the film. An amorphous phase of true metals has neither been proved nor positively disproved. 73 references. GA (9)

9a. Ferrous

J. S. MARSH, SECTION EDITOR

The Fracture of Cast Iron. I. IITAKA & I. YAMAGISHI. *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, Vol. 34, Oct. 1938, pp. 1025-1033. In English. Original research. The authors classify the fracture of metals and alloys into 4 distinct groups, based on the relation found between the path of fracture and the structural constituents, *i.e.* grain, dendrite, slip band, and twin. Round rods of different sizes were prepared by casting Fe into sand molds and permitting them to solidify at different speeds. The rods were then broken with a hammer. A longitudinal section was polished and etched and its intersection with the fracture surface was microscopically examined. All 60 specimens showed the same type of fracture, the path running along the dendrite boundaries and the fineness of the fractured surface coinciding with the dendrite size. Thirteen samples in which a phosphide eutectic was formed by adding excess phosphorus yielded the same result. The path of fracture does not follow the grain boundaries, and the surface of fracture is much finer than the size of the grains. Samples in which flake graphite was obtained in large sizes show that the path of fracture does not always follow the large graphite flakes, but crosses them very often ,and always follows the dendrite boundaries. Small flakes, appearing usually at dendrite boundaries, lie along the path of fracture. EF (9a)

Rapid Electrolytic Method of Determination of SiO_2 in Steel. ADAM SKRAPSKI, ADAM BIELANSKI & MAREK SOBIESKI. *Hutnik*, Vol. 10, No. 9, 1938, pp. 469-473. In Polish. A review of methods used for determination of SiO_2 in steel points out that complicated apparatus, expenditure of much time, or work with corrosive reagents is required in all cases. The electrolytic method of determination of all non-metallic impurities in steel (see *Hutnik*, Vol. 9, No. 9, 1937, pp. 489-496) was modified. Using samples with a surface not less than 30 cm.^{2} and a current of 20-25 amps. and up to 12 v., 4-5 liters of electrolyte of composition 10 g./l. NaCl, 100 g./l. KBr and 30 g./l. Na-citrate is passed through the bath, kept at 50-70° C., within 50 min., whereby about 20 g. of the sample dissolves. The results are in good agreement with those obtained by the bromine method. Applicability of the method to production control is indicated. 2 figures and 12 references. JGT (9a)

The Iron-columbium Diagram (Das Zustandsdiagramm Eisen-Niob) H. EGGERS & W. PETER. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 15, 1938, pp. 109-203. Original research. The Fe-Cb system was investigated thermally, microscopically, and with X-rays; alloys up to 10% Cb were produced in a high-frequency furnace under a pressure of 10^{-2} mm. Hg; the alloys with higher Cb content were made in the Tammann furnace because of their extremely high melting temperatures. Fe forms an intermetallic compound with Cb, probably of the formula Fe_3Cb_2, melting homogeneously at 1650°-1660° C. A Cb-richer compound of the form Fe_xCb_y exists, although it could not be defined. Fe_3Cb_2 forms with δ-Fe a eutectic at 1356° C. with 17.5-18% Cb, and with Fe_xCb_y at 1560° C. with 67-67.5% Cb. δ-Fe disintegrates at 1220° C. eutectoidally into γ-Fe and Fe_3Cb_2; at 965° C., γ-Fe and Fe_3Cb_2 form Cb-ferrite with about 5% Cb. The γ-field is narrowed greatly. A small amount of Cb added to 18/8 steels prevents intercrystalline corrosion, probably through the formation of a stable Cb-carbide. A comparison of the diagrams of Fe-Cb with Fe-V, Fe-Zr, Fe-Mo and Fe-Ta (shown in juxtaposition) shows for V, Cb and Ta the same tendency to narrow the γ-field. The solubility of the added metal in γ-Fe decreases with increasing atomic radius. V and α-Fe give a continuous series of solid solutions at high temperatures; Cb is soluble in α-Fe at 1356° C. with only 7.05 atomic %, Ta at 1430° C. with 2.28%. The metals of the fifth principal group (of the periodic system) form with Fe an intermetallic compound of a melting point that increases with increasing order number, and, simultaneously, the Fe content of the compound increases, $FeV \rightarrow Fe_3Cb_2 \rightarrow Fe_2Ta$. Zr and Mo show similar behavior, but the solubility increases with increasing order number in both α- and γ-Fe, and all have the same type of composition formula: Fe_3Zr_2, Fe_3Cb_2 and Fe_3Mo_2. Tests and measuring methods are described in full. 9 references. **The Iron Corner of the Iron-columbium-carbon Diagram below 1050° C.** (Die Eisenecke im Zustandsdiagramm Eisen-Niob-Kohlenstoff unterhalb 1050°) *Ibid.,* pp. 205-211. Very exact experiments (described in full) show conclusively that low alloy Cb steels have a space diagram with 2 four-phase planes at 705° and 920° C., respectively. The γ phase decomposes at 705° to α Cb_4C_3 and Fe_3C, while at 920° a non-variant conversion takes place: $\gamma + Fe_3Cb_2 \rightleftarrows \alpha + Cb_4C_3$. The 3-phase region $\alpha + \gamma + Fe_3C$ is very small, so that the composition of the ternary α- and γ-solid solutions at 705° is practically the same as the composition of the binary α- and γ-solid solutions of the Fe-C system at the A_1-temperature. Chemical and X-ray examination proved the carbide to have the composition Cb_4C_3, and a density 7.63. 13 references. Ha (9a)

9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

The Cobalt-manganese-aluminum System (Das System Kobalt-Mangan-Aluminium) W. KÖSTER & E. GEBHARDT. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 281-286. Experimental. The region of the ternary system bounded by the phases, Co-Mn-MnAl-CoAl, was examined by thermal, microscopic and magnetic methods. The CoAl and MnAl phase form a continuous series of body-centered cubic solid solutions, which extend over most of the section, while the CoAl-Mn section constitutes a quasi-binary system. Aside from the CoAl and MnAl solid solutions, face-centered cubic Co solid solutions and Mn solid solutions were observed. The solid solubility of Al and Mn in the body-centered phase fell off sharply with temperature. This phase is ferromagnetic throughout. **The Nickel-manganese-aluminum System** (Das System Nickel-Mangan-Aluminium) *Ibid.,* pp. 291-293. In the region outlined by Ni-Mn-MnAl-NiAl, the Ni-Mn-Al system is structurally analogous to the Co-Mn-Al system. The α solid solution formed over a wide range about the compound MnAl is ferromagnetic. GD (9b)

Solubility of Lead and Bismuth in Liquid Aluminum and Aluminum-copper Alloys. L. W. KEMPF & K. R. VAN HORN (Aluminum Co. of America) *Metals Tech.,* Vol. 5, Dec. 1938, T. P. 990, 12 pp. Original research. The solubility of Pb in liquid Al was found to be 1.52% at the freezing point of Al and to increase continuously with temperature to about 14.75% Pb at 1038° C. The solubility of Bi in liquid Al was found to be 3.36% at the freezing point of Al and to increase with temperature to about 15.19% at 877° C. The freezing point of Al (660° C.) is lowered by the presence of Pb to a minimum of 658.5° C. and by the presence of Bi to 657.1° C. The solubilities of Pb and Bi in solid Al were found to be not more than 0.2% by weight at the melting point of Al, and to decrease with temperature. The solubilities of Pb and Bi in molten Al are decreased slightly by the presence in the alloys of about 5% Cu. JLG (9b)

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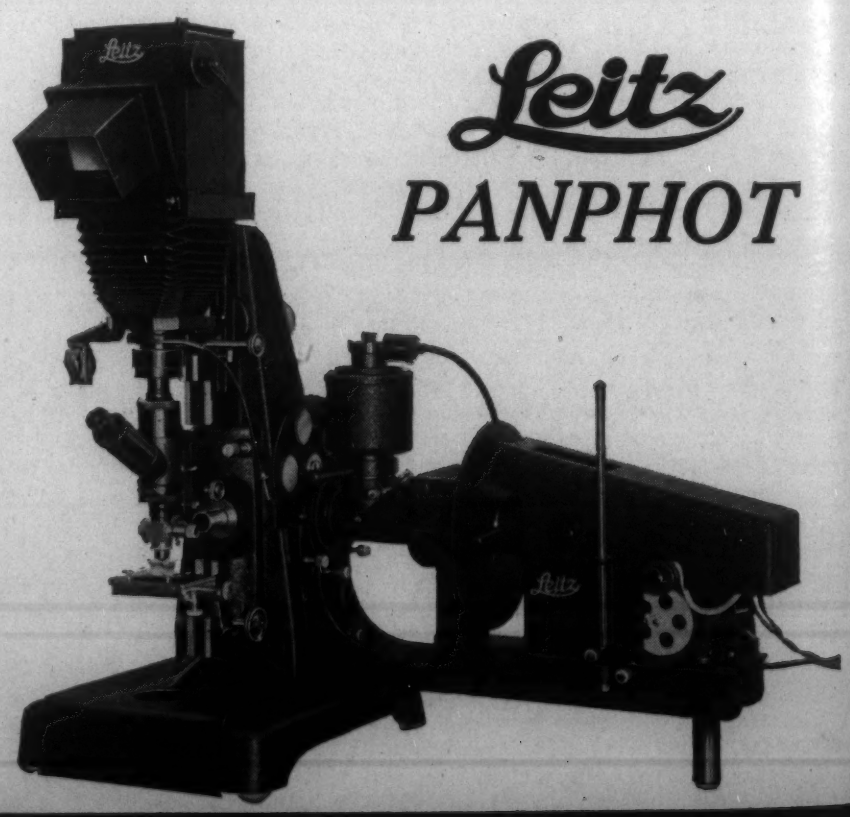

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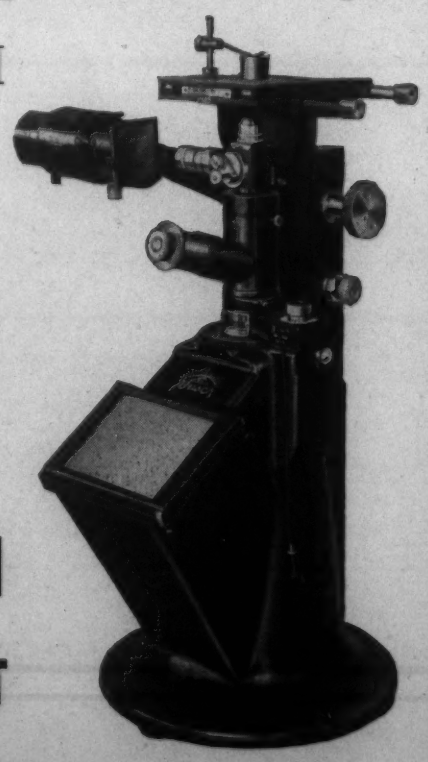

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An X-ray Investigation of Cobalt-aluminum Alloys. A. J. BRADLEY & G. C. SEAGER. *J. Inst. Metals*, Vol. 64, 1938, Advance Copy No. 819, 8 pp. Original research. Al dissolves in the cubic form of Co but not in the hexagonal. It tends to preserve the cubic structure on cooling. After annealing at 320° C. for several days, some of the dissolved Al is precipitated as CoAl, and the residual Co is converted to the hexagonal form. CoAl, which has a body-centered cubic structure, dissolves both Co and Al. The lattice spacing, which is a maximum at the ideal composition, falls slowly on the Co side but more steeply on the Al side. In these alloys there are Al atoms at all cube corners, but the cube centers are deficient in Co atoms. Four Al-rich phases were found. Co_2Al_5 has a hexagonal structure containing 28 atoms per unit cell. The existence of a phase of composition Co_3Al_{13} or Co_2Al_9 was confirmed. The addition of Co to this phase does not give a mixture with Co_2Al_5, as has previously been supposed. The phase in equilibrium with Co_3Al_{13} has the approximate formula Co_4Al_{13}. It has a very complicated X-ray pattern, which is quite different from those of either Co_3Al_{13} or Co_2Al_5. Photographs of alloys near the composition $CoAl_3$ indicate the existence of yet another phase, but this has not been isolated. JLG (9b)

The Intermediate Phases in the Aluminum-copper System after Slow Cooling. A. J. BRADLEY, H. J. GOLDSCHMIDT & H. LIPSON. *J. Inst. Metals*, Vol. 63, 1938, Advance Copy No. 816, 13 pp. Original research. The phase sequence for slowly-cooled Al-Cu alloys containing from 16 to 30% Al was checked by X-ray methods. γ (Cu_9Al_4), γ_1 ($Cu_{32}Al_{19}$) and γ_2 (Cu_3Al_2 are considered to be the same single-phase field, since it is impossible to find a $\gamma + \gamma_1$ or $\gamma_1 + \gamma_2$ phase field. The 3 structures have different superlattices, but are otherwise of the same type, though γ_1 and γ_2 deviate slightly from cubic symmetry. ζ (Cu_4Al_3) and η (CuAl) are totally distinct phases, separated by definite 2-phase regions. Representative specimens of $\gamma + \zeta$, $\zeta + \eta$, and $\eta + \Theta$ have been identified. ζ and η have been reported to exist in 2 forms. The alloys here described presumably belong to the low-temperature modifications. Their structures are more closely related to that of Ni_2Al_3 than to γ, though all are derived from a simple body-centered cubic lattice by the omission of atoms from certain of the lattice points, and by the formation of superlattices. JLG (9b)

The Magnetic Susceptibility of Gold-copper, Gold-silver, Silver-copper and Copper-nickel Alloys (Sur la Susceptibilité Magnetique des Alliages Or-cuivre, Or-argent, Argent-cuivre et Cuivre-nickel) W. BRONIEWSKI, S. FRANCZAK & R. WIKOWSKI. *Ann. Phys.*, Vol. 10, July/Aug. 1938, pp. 5-19. Original research. Chemically or electrolytically purified metals were used for making the binary alloys that were submitted to tests of magnetic susceptibility. The application of this method is highly recommended, as it may yield information, as in the case of Cu-Au alloys, not obtainable by other standard methods. Au-Cu alloys quenched from high temperatures form a continuous series of solid solutions. In the annealed state, 2 constituents occur: AuCu and $AuCu_3$. In the experimenters' tests, the range of mixtures of both constituents is clearly defined; also, the limit where AuCu changes its rôle of solvent to that of solute can be recognized. The Au-Ag diagram, showing susceptibility in relation to chemical analysis, presents a curve slightly concave to the axis of composition (solid solution type) and the Cu-Ni graph shows a continuous passage of the alloys from the ferromagnetic to the paramagnetic state. A nearly straight line was obtained in the Ag-Cu system. EF (9b)

The Manganese-aluminum System (Das System Mangan-Aluminium) W. KÖSTER & W. BECHTHOLD. *Z. Metallkunde*, Vol. 30, Sept. 1938, pp. 294-296. Experimental. The alloys of Al-Mn system were examined in the composition range from 30 to 100% Mn by thermal, magnetic and microscopic methods. The terminal, high temperature δ-Mn phase dissolves up to 17.5% Al and has a melting point maximum at 13% Al. The body-centered cubic compound AlMn forms at 1160° C. by the peritectic reaction melt + $\delta \rightarrow$ AlMn. It extends over the range from 48 to 67% Mn and is ferromagnetic with a Curie temperature of 70° C. Microscopically, it shows profuse twins. Another peritectic reaction, AlMn + melt $\rightarrow$ Al_3Mn occurs at 1095° C. The δ-γ and γ-β transformations of Mn are lowered by increasing amounts of Al. At 1005° C. the eutectoid decomposition $\delta \rightarrow \gamma +$ AlMn occurs, while at about 930° the γ phase has a eutectoid reaction, $\gamma \rightarrow \beta +$ AlMn. β Mn takes about 13% Al into solid solution, however, due to the β-α transformation, Mn holds only about 5% Al in solid solution at room temperature. GD (9b)

Magnesium-rich Mg-Al-Ag Alloys. HIDEO NISHIMURA & HACHIE SAWAMOTO. *Suiyokwai-Shi*, Vol. 9, Oct. 1938, pp. 645-654. In Japanese. The constitution of the Mg-rich alloys containing Al and Ag was investigated by means of thermal analysis and microscopic examination. From various constitutional sections taken through the Mg axis, the following conclusions were drawn: (1) In a range of Al 50% and Ag 50%, there exist the primary separations of (Mg), δ(Mg_3Al_4) and Mg_3Ag. (2) The uni-variant reaction lines were found to be: Liq $\rightleftarrows$ (Mg) + δ, Liq $\rightleftarrows$ (Mg) + Mg_3Ag, and Liq $\rightleftarrows$ (Mg_3Ag) + δ. (3) The non-variant point was: Liq $\rightleftarrows$ (Mg) + δ + Mg_3Ag at 404° C. HN (9b)

Precision Determination of Lattice Constants of Non-cubic Substances (Bi, Mg, Sn) by the Asymmetric Method (Die Präzisionsbestimmung von Gitterkonstanten nichtkubischer Stoffe (Bi, Mg, Sn) nach der asymmetrischen Methode) A. IEVINS, M. STRAUMANIS & K. KARLSONS. *Z. physik. Chem.*, Abt. B, Vol. 40, Aug. 1938, pp. 347-356. Original research. The lattice constants of Bi, Mg and Sn were redetermined by the "asymmetric" powder X-ray method of Ievins & Straumanis (*Z. anorg. allgem. Chem.*, Vol. 238, 1938, pp. 175-188.) The metal samples were pulverized, annealed at 220° C. for 2 hrs., spread thinly on a glass rod, 0.05 mm. diam., and exposed in a camera for 57.4 mm. diam. with thermostatic temperature control, using different radiations. The choice of radiation, the conditions for greatest accuracy, and the procedure of measuring films are dealt with at length. The error does not exceed 0.001%. Purest Bi from Kahlbaum was finely powdered in an agate mortar and exposed to Cu radiation at 26.46° C. Using the coefficients of thermal expansion of $Bi_{11} = 16.2 \times 10^{-6}$ and $Bi_{1} = 12.0 \times 10^{-6}$, the measured values were reduced to: a = 4.53674 ± 0.00004 A.U., c = 11.83834 ± 0.00004 A.U., c/a = 2.60944, at 25° C. Purest available Mg from the Cie. des Produits Chimiques et Electrométallurgiques, Alais, Froges et Camargue, with 99.995% Mg, 0.0006% Fe, 0.0010% Si, 0.0013% Cu, 0.0012% Al, 0.0007% Cl was powdered by scraping with a porcelain shard and exposed to Fe or Ni radiation at 26.61° or 27.08° C. Using the coefficients of thermal expansion of $Mg_{11} = 27.1 \times 10^{-6}$ and $Mg_{1} = 24.3 \times 10^{-6}$, the measured values were reduced to: a = 3.20280 ± 0.00003 A.U., c = 5.19983 ± 0.00005 A.U., c/a = 1.62353, at 25° C. Filings of Sn were exposed at 13.97° C. and other temperatures. From the measurements the coefficients of thermal expansion of Sn were found as: $Sn_{11} = 32.24 \times 10^{-6}$ and $Sn_{1} = 16.77 \times 10^{-6}$, and the lattice constants as: a = 5.81970 ± 0.00002 A.U., c = 3.17488 ± 0.00005 A.U., c/a = 0.54554, at 25° C. The present values agree best with those of Jette & Foote (See *Metals and Alloys*, Vol. 7, June 1936, p. MA 311 L/8). ORS (9b)

Investigation of the Structure of the Compound of Beryllium with Chromium. M. I. ZAKHAROVA & P. I. DAL'NOV. *Zhur. tekh. fiz.*, Vol. 8, Feb. 1938, pp. 252-255. In Russian. Original research. Two mixtures of Cr and Be in the atomic proportions 1/1 or 1/2 were melted, respectively, in a Be_2O_3 crucible in a vacuum high-frequency induction furnace, or in a MgO crucible in a Tammann furnace. Large crystallites removed from the center of the slowly-cooled reguli and containing, respectively, 56.5 or 68.77 atomic % Be, were subjected to X-ray analysis by the pinhole method. After being powdered and annealed, they were also investigated by the X-ray powder method using Cr radiation. In both alloys the crystal lattice was found to be of the hexagonal type belonging to space group D^4_{6h} or D^6_{6}, the lattice constants being a = 4.258 A.U., c = 6.982 A.U. in the first, and a = 4.260 A.U., c = 6.982 A.U. in the second alloy. The authors conclude from these data that in the Cr-Be phase diagram, at lower temperatures, the composition interval from 56.5 to 68.77 atomic % Be is occupied by the region of a single intermetallic phase of the type AB_2 with a hexagonal crystal lattice, analogous to $MgZn_2$, whose constants do not vary within this interval. The crystal lattice of a compound of this type contains 12 atoms per unit cell in the following positions: (A) ⅓, ⅔, -v; ⅓, ⅔, ½ — -v; ⅔, ⅓, ½ + -v; ⅔, ⅓, — -v; (B_I) O, O, O; O, O, ½; (B_{II}) u, -u, ¼; 2u, -u, ¼; u, 2u, ¼; -u, u, ¾; 2u, u, ¾; -u, 2u, ¾. Assuming that, in the alloy with 56.5 atomic % Be, 4 Cr atoms occupy the positions (A) and 1.2 Cr atoms and 6.8 Be atoms are statistically distributed over the positions (B_I) and (B_{II}), the best agreement between observed and calculated intensities of the interference lines was obtained with the parameter values u = 1/6, v = 1/16. ORS (9b)

The Solubility of Chromium in Aluminum (Ueber die Loslichkeit von Chrom in Aluminium) W. KOCH, FINOW & H. WINTERHAGER. *Metallwirtschaft*, Vol. 17, Nov. 4, 1938, pp. 1159-1163. Research. The solubility of Cr in Al was investigated, using resistivity, dilatometric and lattice parameter measurements. All 3 methods checked within experimental error limits. The solubility line is reported at a slightly higher concentration of Cr than that established by Fink and Freche, whose curve was determined microscopically. Maximum solubility is at 0.87% Cr. At low temperatures, resistivity measurements were reliable for solubility measurements, while at high temperatures the X-ray method was most satisfactory. GA (9b)

The Bi-Sn Diagram. T. SATÔ & T. MATUHASI. *Nippon Kinzoku Gakkai-Si*, Vol. 2, Dec. 1938, pp. 592-597. In Japanese. Original research. By various metallographic methods the nature of the proposed intermetallic compound called variously $BiSn_7$, Bi_2Sn, or $BiSn_2$, was clarified. Although discontinuities were observed at about 95° C. in the curves of electric resistance and volumetric dilatation, none was observed in the curves of differential thermal analysis, nor did X-ray analysis confirm the existence of any intermetallic compound in this alloy system. The anomaly is due to the abrupt change in solubility of Bi in Sn solid solution. NS (9b)

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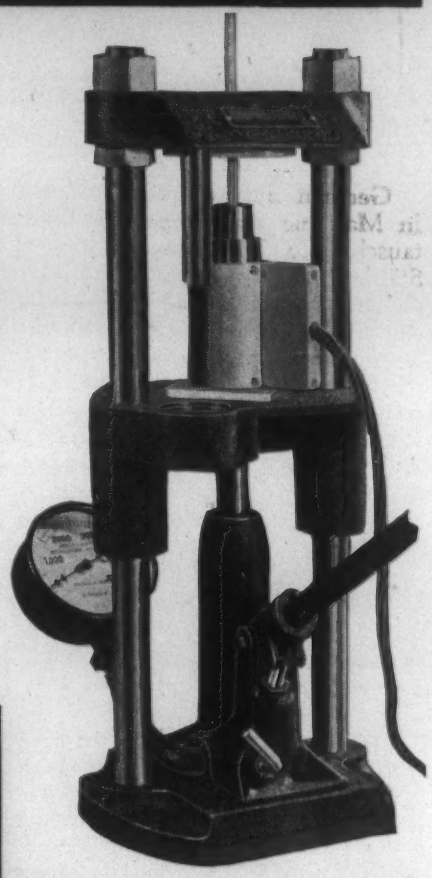

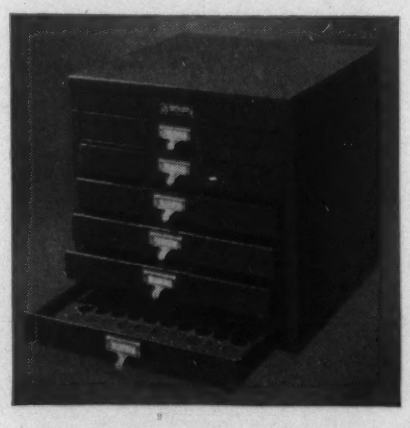

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10 · PROPERTIES AND APPLICATIONS

Including Relation of Properties to Engineering or Product Design. See also Sections 8a and 11.

M. GENSAMER, SECTION EDITOR

German Substitution of Non-ferrous Metals and Alloy Steels in Machine and Apparatus Construction (Einiges über die austauschweise Verwendung von Nichteisenmetallen und legierten Stählen im allgemeinen Maschinen- und Apparatebau) WILLI CLAUS. *Beiträge zur Wirtschaft, Wissenschaft und Technik der Metalle und ihrer Legierungen,* No. 3, 1938, 79 pp. Survey covering the application of non-ferrous metals and alloys within the frame of the 4 year plan, gives production data, consumption, composition, properties and general application of Cu, Ni, Pb, Sn, Zn, Al, Mg and their respective alloys and of Ni and Cr-Ni steels and Cr and Cr-Mo steels, dealing at length with the possibilities of their replacement by other alloys. (1) *Cu and its alloys:* The outstanding properties of hard Cu alloys, useful in apparatus and machine construction, and the increasing application of Cu-clad metals and alloys are stressed. Interesting examples of material-saving without quality impairment are given. The application of the standardized cast Sn bronzes should be dispensed with and they should be replaced by red brass, Pb bronzes, special brasses, Zn, Al and Mg alloys. All cast bronzes should be alloyed with 2% Zn which will not impair chemical and mechanical properties. Also, wrought Sn bronzes can be reasonably replaced by other, and cheaper, alloys. Among the red brasses the alloy Rg 5 (85% Cu, 5% Sn, 7% Zn, 3% Pb is expected to become in time the only red-brass alloy applied in Germany, in comparison with 5 standard types at present. The considerable recent progress in compound castings of red brass/steel is pointed out. Among special bronzes the advantageous application of cast and wrought Al bronzes instead of Sn and similar bronzes is outlined. Pb bronzes are suitable substitutes for all kinds of bearing bronzes with high Sn content, since their running properties are by far superior to the latter. The question of the replacement of As bronzes for fire boxes by Fe is not yet definitely settled. The casting brasses GM_s 58, 63, and 67 are suitable as replacing materials for simple red brasses. To a large extent the casting brasses are replaceable by Zn-containing light metal (Al, Mg) alloys. The wrought brasses and Tombak alloys may be replaced by corresponding alloys with Zn, Al or Mg as base metal. Present developments tend to decrease the use of brass, *e.g.* in the field of sheet metal consumption. As regards their composition, no change is to be observed in the field of brazing alloys. Cd-Zn solders are well suited to steel brazing. In the field of the tableware industry certain types of rustless steel seem able to replace Ni-silver. (2) *Pure Ni and its alloys:* Pure Ni can be saved by using Ni-clad steels and better galvanizing processes. The high Ni contents of Ni-Cu alloys can be decreased without impairing mechanical, chemical and optical properties. The 70% Cu-30% Ni alloy frequently used for condensor tubes can be replaced by special Al-bearing brasses. Ni and Ni alloys should be replaced as far as possible by light metal alloys, rustless steels, etc. Instead of Ni-plating, Cd-plating, bright Ni-plating and phosphate deposits are suitable. (3) *Pb and its alloys:* Soft Pb has been wasted in the past, and may suitably be replaced by stronger Pb alloys, thus making possible considerable weight savings. High-Pb white bearing metals have totally replaced high-Sn bearing metals. In many cases Pb and its alloys have successfully been replaced by Zn, Al and Mg alloys, or by organic materials. (4) *Sn and its alloys:* Sn replacement has been referred to under (3). Soldering Sn can be replaced but to a minor extent. Sn die-casting alloys are replaced by Zn, Al and Mg alloys, and organic materials. (5) *Sand and die cast Zn alloys:* These are the recommended substitutes for simple Sn bronzes and brasses, Al bronzes and the like. On the other hand Zn die casting alloys can themselves be replaced by Al and Mg die-casting alloys. Wrought Zn alloys also find increasing application. (6) *Al and its alloys:* These should be much more widely used; Al, for instance, for making surfaces of high reflectivity, or as cladding material on Cu (Cupal); Al casting alloys as bearing materials; Al wrought alloys as free-cutting stocks and as self-hardening Al alloys of high tensile strength for cladding. (7) The application of *Mg and its alloys* is well known so that no further remarks are required. (8) *Cr and Cr-Mo steels:* In this field the author refers in particular to American experience. 63 references.

GN (10)

Data Sheets on Materials of Construction. 1938-1939 Edition. *Chem. Met. Eng.,* Vol. 45, Nov. 1938, pp. 629-664. The name, manufacturer, nominal composition, forms available and the mechanical and physical properties of more than 800 corrosion, heat and abrasion resistant materials classed in 25 major subdivisions are listed. In addition, the November issue contains a large number of short articles descriptive of the field of application and latest developments of many of the groups of alloys, the titles of which are as follows: Alloy Steel Developments, George A. Sands (Electro Metallurgical Co.) pp. 582-585; High-silicon Irons, W. H. Scott (Duriron Co.) pp. 586-587; Abrasion Resistant Alloys, p. 587; Plain and Alloyed Cast Irons, Editorial Staff, p. 588; Lead and Lead Lined, E. T. Crawford, Jr. (Carbide & Carbon Chemicals Corp.) pp. 589-591; Noble Metals and Alloys, p. 591; Copper Construction, R. A. Wilkins (Revere Copper & Brass Inc.) pp. 592, 593, 596; Aluminum Equipment, H. J. Fahrney (Aluminum Co. of America) pp. 594-596; Nickel and Its Alloys, W. F. Burchfield & F. G. Flocke (Internatl. Nickel Co.) pp. 597-600, 614; Tantalum, p. 600; Silver for Plant Use, A. J. Dornblatt (Am. Silver Producers' Res. Project) pp. 601,608; Glass-lined and Silica, Editorial Staff, p. 602; Industrial Glass, W. A. Kates (Corning Glass Works) p. 603; Chemical Stoneware, Percy C. Kingsbury (Gen. Ceramics Co.) pp. 604-606; Carbon and Graphite, F. J. Vosburgh (Natl. Carbon Co.) pp. 607-608; Plastic Materials, C. R. Runk (Haveg Corp.) p. 609; Rubber Compounds, H. H. Harkins & O. S. True (U. S. Rubber Products, Inc.) pp. 610-611; Wood for Chemical Needs, James K. Stewart, p. 612.

PRK (10)

Bearing Metals. F. A. FOX. *Machinery, London,* Vol. 53, Oct. 27, 1938, pp. 105-109. Comprehensive review. Requirements of bearing metal are: (1) Low coefficient of friction; (2) resistance to wear; (3) strength and plasticity at working temperatures; (4) robustness; (5) resistance to corrosion; (6) high fatigue strength; and (7) strong bond. Alloys used are: (1) Cu base alloys (usually without a backing); (2) white metals; (3) Pb with Ba, Ca or both; (4) Sn alloys; (5) Cd with Ag, Ag + Cu or Ni (except for corrosion resistance, Cd-Ag-Cu is one of most promising recent innovations); (6) molded bearings from powdered metals with controlled porosity. Shells may be made from cast Fe, steel or bronze. Bronze is being replaced by steel, owing to the higher strength of the latter, although bronze has the following advantages: (1) Safeguards shaft in case of failure of bearing; (2) usually bonds better with Sn-base alloys; (3) has coefficient of expansion nearer to that of bearing metal; and (4) has lower modulus, which is sometimes helpful.

JZB (10)

Initial Susceptibility, Magnetization and Permanent Deformation (Susceptibilité Initiale, Aimantation et Déformation Rémanentes) ALBERT PERRIER. *Helv. Phys. Acta,* Vol. 11, June 18, 1938, pp. 360-362. Original research. Experimental determination of the values of the constants a and b in the expression a + bH for the initial magnetic susceptibility of Ni and mild steel in the presence of remanent magnetization either parallel or normal to the field. For Ni, these values were also determined after compression of 0.5% and 1%. The reversible part of the susceptibility is increased by a transverse remanent magnetization and decreased by a parallel remanent magnetization; the irreversible part is decreased in both cases.

EF (10)

Some Factors that Affect the Quality of Electrical Heating Wires. T. EDUKA. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Dec. 1938, pp. 609-617. In Japanese. Original research. With some 16 commercial Ni-Cr and Ni-Cr-Fe wires, the effects of certain factors on strength and electrical resistance were studied. The tensile strength and electrical resistance were much more influenced by working conditions, heat-treatment and surface finishing than by chemical compositions; that is, greater working ratio, smaller grain size and less surface defects give longer life of wires.

NS (10)

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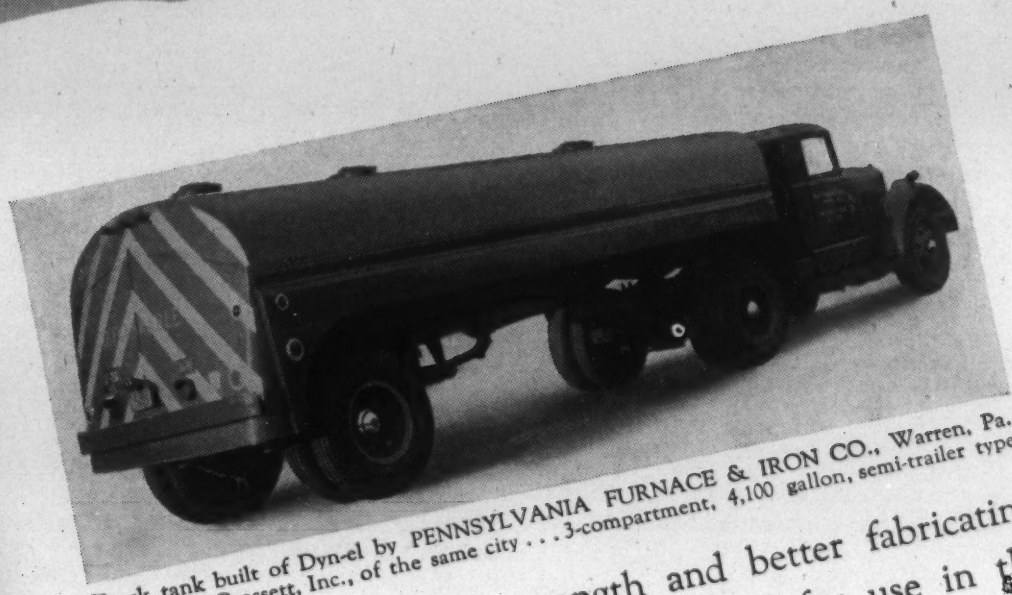

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ALAN WOOD STEEL COMPANY

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Materials Research as Reflected by the Lilienthal Society for Aviation Research (Werkstofforschung im Spiegel der Lilienthal-Gesellschaft für Luftfahrtforschung) ADRIAN. *Automobiltech. Z.*, Vol. 41, Dec. 25, 1938. Review plus original research. Experiments on age-hardening of Al-Cu-Mg alloys showed that alloys with low Cu-content and higher Mg content age harden much slower than regular Duralumin. At 20° C. noticeable hardening begins 12 hrs. after quenching. The characteristic structural feature of the ordinary free-machining materials is the presence of heterogeneous inclusions that act as chip-breakers. For the purpose of developing free-machining light alloys the following were tried: (1) To add insoluble soft metals and (2) to obtain a structure with a hard primary precipitate. Pb is applied mostly as the insoluble soft addition, and a process has been developed according to which Pb is distributed evenly through the melt. The best cutting properties for age-hardening alloys were found to exist in the hardened state. Al-Cu-Mg alloys are usually aged at room temperature. At higher temperatures, properties such as hardness and yield point are greatly improved, but the fatigue limit is lower and the notch effect greater. At those temperatures and periods which yield maximum value for yield point and hardness, the metal is outside the temperature range of susceptibility to intercrystalline corrosion. The corrosion resistance can be increased by plating with Cu-free Al-alloys or pure Al. Surface oxidation (Eloxal-process) should not be carried out in the artificially-aged state, but between quenching and reheating. The fatigue strength, tensile strength, yield strength and elastic limit increase with decreasing temperature. The drop in strength under dynamic stress is greater for Al-Mg than for Duralumin, when the original fatigue strength of smooth specimens was equal. An Al-Mg alloy containing Zn and Cr showed good resistance to intercrystalline corrosion when tested with 3% Na-Cl solution with H_2O_2-addition and under saltwater spray. The stress-corrosion of Zn-containing sheets even after annealing up to 100° C. is considerably lower than that of the plain material. It is claimed that low-Ni steels for crankshafts are equal to high-alloy steels; the fatigue limit is the same. By proper design a crankshaft from low-strength, practically non-alloy material can meet fatigue stress requirements in airplane engines. Improvement of pistons by surface treatment was tried. No advantages were obtained by oxidation (Eloxal-process). Sn coating is already in practical use. Tests are being run with coats of plastics and of Pb. Surface oxidation of the bottoms of pistons reduces the heat absorption, and thus protects against overheating. Tests are under way with Cr and Ni coatings. The bending fatigue limit gives no measure of the endurance of piston alloys at elevated temperature. "Growth" of piston rings could not be noted below 450° C., so that no danger exists in practical operation. Welding of Al-Mg and other Al-alloy sheets can be used instead of riveting. Annealing between 60°-330° C. after welding is advantageous; for some alloys a previous annealing must be applied. Investigation of non-destructive testing methods led to the following observations: Short time stressing above the fatigue limit causes lattice changes; below the fatigue limit no changes were observed. Small disturbances were detected close to the fatigue limit. RPS (10)

Cylinder Sleeve Linings (Was halten Sie von Zylinder-Laufbüchsen?) G. BAUMGART. *Motorwelt*, Vol. 36, Dec. 1938, pp. 920-923. Practical. The idea of providing interchangeable cylinder linings is old, but the linings must be of a higher grade material than the block to justify the increase in work and cost. By additions of Ni, Cr, Mo, Cu, etc., improved cast irons were created for this purpose. Ni-alloy casting with C as flaky graphite shows good wear resistance. The Fe used for cylinder linings is melted in cupolas, then refined and alloyed in electric furnaces, and the pieces are made by centrifugal casting, producing a very dense material, free from pores. The sleeves are taken out of the mold red hot. A series of machining operations follow. The practical importance is based on the possibility of using ordinary casting for the block and special alloy casting for the cylinder linings. RPS (10)

Magneto-electrolytic Method for Producing Marked Anisotropy (Méthode Magnétoélectric pour Réaliser de Fortes Anisotropies) A. PERRIER & C. MERMOD. *Helv. Phys. Acta*, Vol. 11, July 18, 1938, pp. 362-364. Original research. The anisotropic behavior of Co electrolytically deposited in a magnetic field of several hundred oersteds was studied. The pronounced orientation of the electrodeposits corresponds in an alternating field with the axis of the alternating field, and the deposit behaves like a single crystal whose axis is arranged along the line of easiest magnetization. The anisotropy of the deposits, which are magnetically very hard, can be demonstrated by scratching with a graving tool. The thermal stability of the anisotropy is remarkable. No change occurs during several hours annealing at 1200° C. **Magneto-electrolytic Anisotropies** (Anisotropies Magnétoélectrolytiques) *Ibid.*, Oct. 15, 1938, pp. 468-469. Original research. The previous experiments on Co (see foregoing abstract) were extended to the other 2 ferro-magnetic metals, *i.e.* Ni and Fe, and the same phenomena were observed as with Co. EF (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

On the Properties of C-rich Fe-Mn-C Alloys, in Particular their Applicability as Hard Alloy (Ueber die Eigenschaften kohlenstoffreicher Eisen-Mangan-Kohlenstofflegierungen, insbesondere ihre Verwendbarkeit als Hartmetall) GÜNTHER HAENSEL. *Doctor's Thesis, Tech. Hochschule Breslau*, 1938, 30 pp. Original research. Hardness determinations, microscopic, X-ray, annealing and nitriding experiments and cutting tests were used to investigate the applicability of Fe-C-Mn alloys, with C contents of from 2.67-4.17% and Mn contents of from 1-5%. Variable hardnesses are attained with constant C and Mn content, depending on the cooling conditions in casting the alloys. The hardness increase with increasing C content is caused by the increasing formation of carbides. The microscopic investigations show that pearlite formation is rendered more difficult with rising Mn content. With the disappearance of the pearlite transformation at about 5% Mn and subsequently the disappearance of α-Fe, a solid solution of carbides in γ-Fe is present at these Mn contents. The X-ray examination substantiated these microscopic findings. The presence of troostite in the alloys of 1-3% Mn gave the α-Fe lattice. In the annealing experiments to improve the properties of the alloys, the highest hardness improvement was attained with the 5% Mn-3.9% C alloy after 1-hr. annealing at 750° C. The cutting tests substantiated the results of former investigations by Sauerwald & Kubik (Doctor's Thesis, *Tech. Hochschule Breslau*, 1930). The "radiated crystals" formed upon casting the alloys in Fe molds were to stand vertically to the cutting edge. 30% better cutting results were achieved upon casting the alloys in water cooled Cu molds. Best cutting results were given by the 5% Mn alloy in the annealed state. The cutting capacity of this alloy corresponds to that of an 18% W high speed steel. The nitriding experiments (500° C., 120 hrs.) on 2 alloys of 2.5% Mn, 3.44% C and 5% Mn, 3.82% C, respectively, proved unsuccessful, probably due to the presence of highly stable Mn carbides. GN (10a)

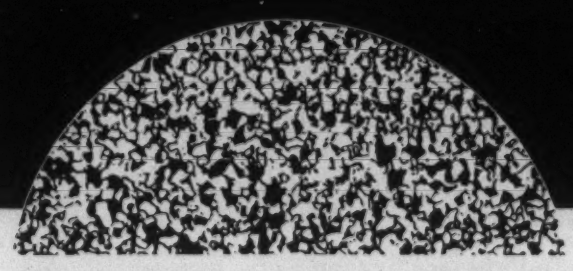
Magnetic Hysteresis in Single Crystals. Preliminary Communication. YA. SHUR & R. YANUS. *Zhur. eksp. i teor. fiziki*, Vol. 8, Jan. 1938, pp. 67-69. In Russian. Original research. The normal component of magnetization with reference to the direction of the external field, in relative units, and the coercive force of single crystals and polycrystalline samples of transformer steel with 3.5% Si were determined. The single crystals were cut out from strips of sheet cold deformed by stretching and subsequently recrystallized at high temperatures; the magnetic measurements in all crystallographic directions could be made on the same specimen. The normal component of magnetization was determined at a field of 600 oersteds. The coercive force was measured, after an initial magnetization of 800 oersteds, by the force of the reverse current in the solenoid at which the expulsion of the specimen from the measuring coil produced no deflection of the ballistic galvanometer. The *preliminary results* given in this paper show that, in single crystals, the coercive force varies with the crystallographic orientation within the limits of 0.1 and 0.3 oersteds, in agreement with the findings of Ruder (see *Metals and Alloys*, Vol. 5, Nov. 1934, p. MA 533) and Sixtus (*Phys. Review*, Vol. 50, 1936, p. 395). The anisotropy of the coercive force has a complex character differing greatly from that of the magnetic permeability, and does not obey Ruder's formula. In polycrystalline samples, the coercive force is nearly uniformly about 0.4 oersteds at small grain sizes of up to 1 to 2 mm., but decreases greatly as the grain size increases, attaining the value of about 0.2 oersteds, *i.e.* the mean value for single crystals, at a grain size of 3 to 4 mm. ORS (10a)

The Development of the Grooved Rail. A Contribution to the History of Rail Manufacture (Die Entwicklung der Rillenschiene. Ein Beitrag zur Geschichte der Schienenfabrikation) ARTHUR TIX. *Tech. Blätter*, Vol. 28, Sept. 18, 1938, pp. 544-546. Paper considers the history from the standpoint of metallurgical quality improvement, outlining the different welding methods applied, discussing the mechanical properties of head-hardened rails, of wear resistant natural hard rails of high C, or of high C and Mn content, of wear resistant Mn, Cr, V and Mo alloyed rails and of compound rails. Compound rails cannot be dispensed with for tramways. GN (10a)

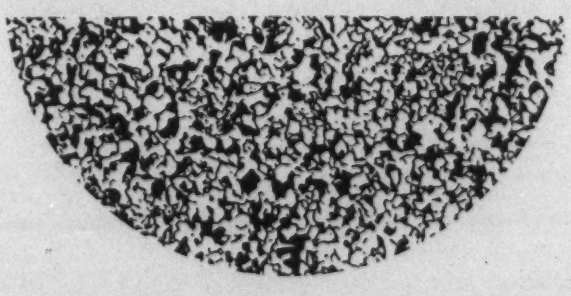
The Brake Shoe, an Outline of its History and Development. M. N. TRAINER. *Southern & Southwestern Railway Club Proc.*, Vol. 26, Jan. 1938, pp. 8-27. An historical description of the materials used in brake shoes, and how modern steels have helped to shorten time and distance of stopping heavy trains by increasing the friction and at the same time increasing the heat capacity and heat-dissipating property. Cast Fe is today the only material that is used successfully for the body of the shoe itself, no other material tried being equal to it. Ha (10a)

National Steel high tensile alloy combines high strength with unusual

Ductility



ITS INHERENTLY FINER GRAIN MAKES ALL THE DIFFERENCE



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The Mechanical Qualities of Open-hearth Steels. KÊZIRÔ KUROKAWA. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, Part II, pp. 1322-1355. In English. Extensive review and original research. The object of this investigation was to help the "national policy of a Ni-short country" (Japan) by "quickly changing the focus of alloy steel technique from Ni series to Ni-free chrome series." The author concludes, "Unless these experimental data are distrusted, we need no longer depend on Ni to get a steel of high mechanical quality; changing to Cr and Mo will effect excellent strength and toughness of steel. Moreover, most of the defects that used to be fatal in steel objects are expected to be gotten rid of by giving up Ni in steel." The experiments were carried out with small objects to be certain of obtaining a rapid quench. It is admitted that the "results can not be directly applied as true in the case of large objects." Chemical analyses are given and the testing results are clearly arranged in 21 diagrams. The first set shows changes of yield point, tensile strength, elongation, contraction and impact value in relation to tempering temperature for the following group of steels: C-steel and Ni (3.5%)-steel, Ni-Cr and Ni-Cr-Mo steel (3 different analyses), Cr-Mo steels (2 grades). The minimum impact value of the Ni-Cr steels is much lower than that of Ni-Cr-Mo. Mo (0.5%) diminishes temper brittleness and induces toughness. The minimum impact value of Cr-Mo steel is found at a higher temperature than that of Ni-Cr-Mo. After tempering above 400° C., the impact value of Ni-Cr-Mo steel is inferior to that of Cr-Mo steel. The tempering temperature of the latter can be raised to 750° C. or more since Ac_1 is elevated by the preceding quenching. Thus, the mechanical properties can be controlled to a wider extent. The impact value of Cr-Mo steel increases with the Cr content up to 3% over a large tempering range. In C steel, the impact value will gradually decrease as the tempering temperature is raised above 200° C. In Ni-Cr steel, a minimum generally occurs at about 300°-350° C., but when Cr is high, this minimum seems to move to higher temperatures, reaching 500° C. when Cr is over 8%. A second series of 8 diagrams correlates impact value and tensile strength of more than 50 Japanese steels. Cr-Mo steels containing 2.0-3.0% Cr and 0.5% Mo offer the best combination of high tensile and impact strength. The undesirable effect of C is not very pronounced in this type of steel. Ni steels are not safe from white spots, even in the presence of the supposedly harmful Cr or Mo. If C is controlled adequately, higher Cr steels are relatively free from white spots and "practically safe" above 2.5% Cr. The Cr-Mo steels are considered to be a match for Ni-Cr-Mo. It is better to use no Cr at all and increase C and Ni than to use inefficient amounts of Cr. A 2% Cr-0.5% Ni steel is better than a 2% Ni-1% Cr steel. Some of the laboratory experiments were checked on castings of over 20 tons. Ni steel was not found "good enough for uniform quenching." Ni-Cr steels were a little tougher than Ni steels. The results on Ni-Cr-Mo checked the experimental findings, and its quenching characteristics were superior to those of Ni or Ni-Cr steel. The low Ni, medium Cr steels show excellent quenching effects, indicating that it is better to increase Cr rather than Ni. It is superfluous to add more than 1% Mo. 0.5% Mo is sufficient to confer self-hardening. The results on creep show that Ni detrimentally affects this property.
EF (10a)

Copper-steel Castings. MARTIN ALEXANDER. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 61-72. Original research. The effect of 1% Cu was investigated in cast steels containing a little less than 0.3% C with high and low Mn contents, with 0.8% Cr, 1.5% Ni and 1.5% Ni together with 0.5% Cr. Results, including the macroscopic examination of castings, indicated that Cu is a valuable alloying element in steel castings. It improves the mechanical properties of the annealed steels and renders the castings susceptible to a hardening treatment that can be carried out at a temperature below the critical range without distortion or the setting up of internal stresses. The full effect of the temper-hardening treatment cannot be carried out on account of the accompanying embrittlement. To avoid an undue fall in impact strength, it is necessary to keep the C low and to heat at a temperature higher than that giving maximum hardness. With a carefully balanced composition and suitable treatment very good mechanical properties may be secured in castings by the addition of Cu to a variety of low-alloy steels. JLG (10a)

Specific-heat/Temperature Curves of Commercially Pure Iron and Certain Plain Carbon Steels. C. SYKES & H. EVANS. *J. Iron Steel Inst.,* Advance Copy No. 15, Oct. 1938, 23 pp. Original research. Measurements of specific heat by a modified aneroid method in the range 80°-450° C. were made on a number of samples of commercially pure Fe and C steels. The results are in reasonable agreement with accepted values. No experimental evidence was found that confirmed the presence of the discontinuities reported by Naeser and Dearden. An examination of the published literature dealing with abnormalities in physical properties of Fe indicated that the indirect evidence which it brings to the support of the results of Naeser and Dearden is not strong. 55 references. JLG (10a)

Vanadium in Steel and Iron. W. J. PRIESTLEY (Electro Metallurgical Co.) *Metals and Alloys,* Vol. 9, Aug. 1938, pp. 193-197; Sept. 1938, pp. 237-241. A complete history of the discovery of V, the occurrence of the V-ores, its properties, effects in steel, uses and applications are well presented in this article. No important commercial use for pure V has been developed. This element is used in the non-ferrous field in an alloy of Cu and V for use in propellers for salt water. Ferro-V is the principal outlet for V at the present time. V is an excellent deoxidizer and degasifier of molten steel. V progressively increases the tensile strength and, more especially, the elastic limit of steel, until a V content of 1% is reached; above 1% V, these properties are not increased and may even be decreased. C-V steels are used in the railroad industry and also for small forgings, for heat treatment produces exceptional properties. Low C-V steel makes excellent welding rod for oxyacetylene welding. Low C-V steels, being easily heat-treated, are used for case-carburized parts that are subjected to wear involving high stresses. Medium C-V steels are employed for gears, axles and, in some cases, crankshafts, etc. High C-V steels are used for ball and roller bearings, wearing plates, dies, etc. Mn-V steels, Mn-Cr-V steels and special V-steels containing Cr, Ni, Mo and Mn are discussed; the Mn-Mo-V combination is adaptable to elevated temperature service, as it has a considerably lower creep rate than the well-known 18:8 Cr-Ni stainless steel. V is used in cast Fe. From 0.10 to 0.15% V in cast Fe increases the strength of the Fe from 10 to 25%, and adds a considerable amount of toughness as a direct result of the uniform grain size produced. Ni-V-cast irons possess good wear-resistance properties and are used for heavy forming dies. The addition of 0.75% Cr to the Ni-V-cast Fe gives a hard, wear-resisting alloy, applicable for dies and chilled rolls. It is possible to obtain 60,000 lbs./in.^{2} tensile in as-cast Fe of such a combination. V in combination with Ti prevents high-C high-Si irons from chilling rapidly, even in thin sections, and is used for the manufacture of piston rings. With the addition of 2% Cr to a V-cast Fe, a tensile strength of 75,000 lbs./in.^{2} can be obtained along with other favorable properties. CWH (10a)

Temperature-sensitive Magnetic Alloys and their Uses. L. R. JACKSON & H. W. RUSSELL (Battelle Mem. Inst.) *Instruments,* Vol. 11, Nov. 1938, pp. 280-282. Original research. The purpose of this investigation was to find the most suitable temperature-sensitive alloys that change their magnetic permeability over a sufficiently wide temperature range. A few devices where such alloys are applied in temperature-sensitive contactors, reactors and transformers are briefly described. A suitable alloy must not change its Curie point much with slight variations in composition; the Curie point should be independent of heat treatment and be the same for rising and falling temperatures. The permeability below the Curie point should be as high as possible and the alloy must be workable. Preliminary investigations on various alloy systems indicated that Fe-Ni-Cr-Si alloys satisfy the requirements most completely. Experimental data are graphically presented, showing the Curie points in relation to chemical composition (0-20% Cr), the magnetization values at 25° C. in a field of 30 oersteds (0-15% Cr), the temperature/magnetization of a 35% Ni, 5% Cr, 60% Fe + Si alloy and the room temperature/magnetization curves of a few typical Fe-Ni-Cr-Si alloys. The alloys were melted in a high-frequency induction furnace, cast into ½ in. bars of 8 in. length annealed at 1800° F. tested ballistically, hot rolled to ¼ in. diam. rod, annealed at 1800° F. and retested. The Curie point of a given Fe-Ni alloy is lowered by 1% Si as much as by 4% Cr. More than 1% Si harmfully affects workability; 2% Si introduces another phase with a higher Curie point in alloys containing less than 40% Ni. In the alloys reported, the Si content was constant at 0.3%. EF (10a)

Mechanical Properties of Turbine Blades and Discs after Several Years' Successful Operation (Werkstoffeigenschaften langjährig bewährter Turbinenscheiben und -schaufeln) KARL DAEVES. *Wärme,* Vol. 61, Aug. 13, 1938, pp. 595-598. Original research. Wheel discs and blades of turbines that have operated satisfactorily since about 1916 were tested for chemical composition, microstructure, strength at elevated temperature, impact strength and other room temperature mechanical properties. Relatively high P and S contents, 0.005-0.008% and 0.04-0.07%, respectively, did not affect the service qualities. A few typical analyses show (a) 1-1.4% Mn, 0.3-0.4% C, (b) 0.5-0.8% Mn, 0.3-0.4% C, (c) 0.78% Cr, 1.9% Ni, 0.33% C. Considerable variations of impact strength were observed without any detrimental effect on service performance. Elongation values vary between 8% and 25%. Comparisons with modern specifications are made. There is no intimate relation between analysis and static tests (tensile, impact) on one hand and the service qualities on the other. It is, therefore, illogical to expect greater safety or better serviceability by making the specifications more severe. A greater uniformity of the physical properties is more desirable than unnecessarily severe specifications calling for more expensive materials.
EF (10a)

The Timken Roller Bearing Company manufactured alloy steel for its own use in the production of TIMKEN Bearings a long time before TIMKEN Alloy Steel and TIMKEN Steel Tubing became available to other steel users. We started making our own steel because we wanted steel that would consistently meet the high quality standards demanded for TIMKEN Bearings. The steel we offer for sale today is made to the same quality standards, by the same methods and is subject to the same strict system of tests as the steel that goes into our own product. You could have no stronger assurance of its fitness for yours.

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The Change of Young's Modulus of Elasticity by Magnetization of Iron and Carbon Steels. M. YAMAMOTO. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Oct. 1938, pp. 495-502. In Japanese. Original research. The change of Young's modulus of elasticity by magnetization in annealed Armco Fe and various C steels, was measured by a magnetostrictive oscillation method. Young's modulus of elasticity in these materials increases by magnetization, and the amount of increase is of the order of 10^{-3}. The rate of increase is large in weak magnetic fields, and becomes gradually less as the field increases. For a given magnetic field, $\Delta E/E$ decreases continuously as C content increases. Every $\Delta E/E$ vs. intensity of magnetization curve consists of 3 stages. Akulov and Kondorsky's theory was confirmed for the total change of elasticity in Armco Fe. The initial susceptibility plays an important rôle in the change of Young's modulus of elasticity by magnetization in Fe and C steels. NS (10a)

Nickel-boron Cast Iron for Resistance to Abrasion. WALTER F. HIRSCH (Ind. Res. Labs., Ltd.) *Metal Progress,* Vol. 34, Sept. 1938, pp. 230-232, 278. Descriptive. The introduction of B into cast Fe caused a white fracture, even though a graphitizing element such as Ni was present. The resulting white Fe was considerably harder than ordinary white Fe, and also possessed exceptional abrasive resistance properties. When B is added to Fe-C alloys, it effectively prevents graphitization, unless the Si content is unduly high. As little as 0.25% B added to an ordinary gray Fe will render it white. B apparently enters into combination with the cementite and greatly increases its stability. With the addition of 4% Ni to such an Fe, the maximum hardness is obtained, as demonstrated by a comparative graph, and the air-cooled structure of martensite and cementite are well illustrated in 2 photomicrographs. The direct reduction of B from B compounds is recommended for the production of commercial alloys. The physical properties and applications of such Fe-B alloys are described. CWH (10a)

The Effect of Copper, Molybdenum, Tungsten, Titanium and Vanadium on the Magnetic Properties of Iron-nickel-aluminum Alloys. A. ZAIMOVSKII, P. DENISOV & N. VOLKENSHTEIN. *Stal,* Vol. 8, May 1938, pp. 60-64. In Russian. Original research. Cu, Mo, W, Ti and V were added to the extent of 3, 6 and 9% to an alloy containing 20-28% Ni, 9-15% Al and balance Fe. Cu increased the coercive force of 25-28% Ni and 13-15% Al alloy in the cast condition without decreasing the residual induction. Cu was not beneficial in alloys containing 11% Al, *i.e.* in those requiring quenching to develop maximum magnetic properties. Mo and W lowered both coercive force and residual induction. Ti and V increased coercive force and decreased residual induction a corresponding amount. HWR (10a)

Properties of Mild Steel Made of Sponge Iron. KAZUJI KUSAKA. *Tetsu-to-Hagane,* Vol. 24, Mar. 25, 1938, pp. 281-285. In Japanese. Experimental. Using sponge Fe industrially manufactured by a special rotary kiln from rich Fe ores produced in Manchukuo and China, mild steel (0.06-0.11% C) was made in a high frequency induction or in an electric arc furnace. Mechanical properties and weldability of this steel were tested and the following results obtained: Tensile strength, elongation and reduction of area of this mild steel were 1-7% higher than those of an ordinary mild steel. Impact resistance of the special steel, when the latter was cooled in a furnace from 900° C., was 3-7 times, and when quenched from the same temperature, was 1.7 times that of the ordinary steel. The weldability of the mild steel made of sponge Fe was better than that of an ordinary one. TS (10a)

Thermal Expansion of Nickel-iron Alloys (Nickel from 30 to 70 Per Cent) J. M. LOHR & CHARLES H. HOPKINS (Driver-Harris Co.) *Metals Tech.,* Vol. 5, Dec. 1938, T.P. 987, 7 pp. Original research. Expansion curves of 23 Ni-Fe alloys resulting from an effort to find satisfactory alloys for sealing into various types of glass, and containing from 30 to 70% Ni, were obtained. Special attention was given to alloys in the range 40 to 55% Ni. Over this range, observations were made on alloys of which the variations in Ni content were small. Heating and cooling curves are shown, and curves showing the effect of Ni content on both the inflection temperature and on the expansion up to the inflection temperature are given. JLG (10a)

Statistics of Rail Failures on German Railroads (Die Schienenbruch-Statistik der Deutschen Reichsbahn) V. HERWIG. *Stahl u. Eisen,* Vol. 58, Oct. 20, 1938, pp. 1129-1137. Practical. The familiar types of rail failures, such as transverse fissures, split heads, exfoliation of the heads, wheel burns, breaks due to segregation, rusting, cracks through the bolt holes for splice bars, etc., are described and the statistics on their incidence in the 5 years to 1937 given. The German railroads have kept records of these classified failures as related to the type of road and service, and to the grade of steel. It is hoped that these statistics will help reveal the causes of some of these failures and indicate how they may be avoided. SE (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

A Study of the Mechanical Properties of Tin-rich Antimony-tin Alloys. D. HANSON & W. T. PELL-WALPOLE (Univ. Birmingham) *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 810, 22 pp. Original research. Tensile and Brinell tests were made on alloys containing 2-18% Sb in the form of machined chill-cast specimens, rolled strip and extruded wire. Results are given graphically. In any condition, little improvement is obtained by using more than 9% Sb. The effect of progressive amounts of cold work on Brinell hardness was studied. Alloys containing 4.5-7% Sb can be permanently hardened by 10-30% reduction, but an alloy with 14% Sb cannot be permanently hardened even by small amounts of reduction, and severe cold working produces pronounced softening. Grain size may be an important factor in work softening and in subsequent recovery by annealing. Quenching from 225° C. produces a slight improvement in alloys containing more than 10% Sb, but has no effect on alloys with less Sb. Tempering at 100° C. after quenching from 215-240° C. causes softening in alloys containing more than 12% Sb, but the same treatment produces temper hardening in alloys containing 7-10% Sb, the maximum effect being obtained with 9% Sb. It is noted that grain size may have a marked influence on tensile strength of the alloys. JLG (10b)

Temperature Scale and Thermionic Emission from Rhodium. H. B. WAHLIN & L. V. WHITNEY (Univ. Wisconsin) *J. Phys. Chem.,* Vol. 6, Oct. 1938, pp. 594-597. Original research. When Rh is heated to incandescence in an atmosphere of O or air, a coating forms on its surface; this is shown by a change in the emissivity. When the temperature is increased sufficiently, this coating suddenly disappears and when the temperature is lowered, it reappears. This coating is probably an activated adsorption of O or an oxide of Rh. Experiments proved that the temperature and partial pressure of O at which the coating disappears are related by the Clausius-Clapeyron equation: $(d \log_e P)/dT = L/RT^2$, wherein P = partial pressure of O, T = absolute temperature and L = heat of vaporization of the surface. The work function of a clean Rh surface is found to be 4.80 electron-volts and Richardson's constant to be 33 amps./cm.^{2}/deg.^{2}. EF (10b)

Elastic Properties and Grain Size of Aluminum Wire. MIYABI SUGIHARA. *Mem. Coll. of Sci., Kyoto Imperial University,* Series A, Vol. 21, Sept. 1938, pp. 163-168. Research. In Al wire Young's modulus has the same value independent of the grain sizes. On the other hand, the elastic limit depends upon the grain size. This is probably because the elastic limit of the grain itself is greatly affected by its boundary, which is elastically stronger. Under such a consideration, the relation between the elastic limit and the grain size number may be expressed by a relatively simple formula. For previous work see also *Metals and Alloys,* Vol. 9, Jan. 1938, p. MA 44 R/1. HN (10b)

Magnetic Permeability of Nickel to Hertz Oscillations (Ueber die magnetische Permeabilität des Nickels für Hertzsche Schwingungen) KARL F. LINDMAN. *Z. tech. Physik,* Vol. 19, Oct. 1938, pp. 323-324. Original research. Employing the author's method described in *Z. tech. Physik,* Vol. 19, 1938, p. 159, and using 2 parallel Ni wires, 0.072 mm. dia., the magnetic permeability (μ) of Ni to Hertz oscillations of various wave length (λ_0) within the interval from 15.8 to 86.0 cm. was found to be as follows:

$\frac{1}{2}\lambda_0$ cm.	μ
7.9	3.1
13.0	6.3
18.0	13.0
24.2	18.4
43.0	19.9

ORS (10b)

Overhead Lines of Cadmium-copper (Les Conducteurs en Cadmium-Cuivre pour Lignes Électriques Aeriennes) G. W. PRESTON. *Cuivre et Laiton,* Vol. 11, Nov. 30, 1938, pp. 487-491. Review. Cd-Cu wires are used for telephone and telegraph lines; they contain 0.9% Cd, have an electric conductivity of 85% of that of Cu and a tensile strength of 100,000 lbs./in.^{2} For the larger conductors of overhead lines 0.8-1.0% Cd is added to Cu; the fatigue resistance is higher than for other materials with equally high conductivity. A table with comparative electrical and transmission line characteristics for hard-drawn Cu and for Al cable with steel core is added. Ha (10b)

Hydration by Colloidal Rhodium (Hydrierung durch kolloidales Rhodium) C. ZENGHELIS & K. STATHIS. *Sitzber. Akad. Wiss. Wien, Math. Naturw. Klasse, Abt. IIb, Chemie,* Vol. 147, No. 2, 1938, pp. 134-138. Original research. As a catalyst in hydration processes, colloidal Rh was found to yield the same results as colloidal Pt and Pd. Rh even furnished greater reaction speed. In some cases, Rh was suitable where Pt and Pd failed to operate. Rh is superior to all other metals of the Pt group as well as to Ni at ordinary temperatures. EF (10b)

The Elastic Properties of Some Anti-friction Alloys at Room and at Elevated Temperatures. J. W. CUTHBERTSON. *J. Inst. Metals,* Vol. 64, 1938, Advance Copy No. 818, 23 pp. Original research. A plane bending test with interferometer deflection-recording mechanism was adapted to the determination of the elastic moduli of cast Sn and a series of Sn-base alloys at room and ordinary temperatures. All of the materials examined creep under relatively low stresses, but obey Hooke's law if the load is applied with sufficient rapidity. A standard rate of loading was therefore adopted throughout. There is little difference between the elastic modulus-temperature curves of high-Sn alloys, although E tends to increase as the Sb content increases. Pb, even in small quantities, alters the shape of the curve and leads to failure by creep at or near the melting point of the Pb-Sn eutectic. Cd in amounts up to 1% has little effect. Above 50° C., and almost up to the melting point, the curve for Sn falls linearly, but less steeply than the curves for the Sn alloys, and intersects the latter near 210° C. The Pb-base alloys have lower elastic constants than the true Babbitts and, with the exception of Bahnmetal, fail by creep at or well below 180° C. An appendix contains the hardness values and Hargreaves flow indices for the alloys investigated. JLG (10b)

The $Mg\text{-}Al_3Mg_4\text{-}Mg_5Tl_2$ Region of the Ternary Magnesium-aluminum-thallium System (Der Teilbereich $Mg\text{-}Al_3Mg_4\text{-}Mg_5Tl_2$ des Dreistoffsystems Magnesium-Aluminium-Thallium) W. KÖSTER & E. WAGNER. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp.338-342. Experimental. The liquidus surface for the Mg corner of the Mg-Al-Tl system was determined by thermal analysis and microscopic observation. The ternary eutectic of the Mg, Al_3Mg_4 and Mg_5Tl_2 phases is at 395° C. and 32.5% Mg, 5% Al, 62.5% Tl. The limits of the ϵ phase, the Mg-rich solid solution, were determined by temperature-resistivity curves. At the eutectic temperature the Al content of the ϵ phase is 12.1, 11, 9 and 7% for 0, 10, 20, 30% Tl, respectively; while at room temperature the Al content varies from 2.5 to 1%. In the cast alloys, hardness was increased more by additions of Al than of Tl. Aging experiments showed the maximum hardness was obtained from an alloy of 71.8% Mg, 8% Al, 20% Tl, 0.2% Mn when annealed at 200° C. The resistance to atmospheric corrosion was increased by additions of Al. Corrosion resistance to distilled water was increased by Al additions within the ϵ solid solution range only. Aging at 250° C. produced the greatest corrosion in the 71.8% Mg, 8% Al, 20% Tl, 0.2% Mn alloy. GD (10b)

The Effect of Small Additions of Tellurium on the Mechanical Properties of Pure Tin. D. HANSON & W. T. PELL-WALPOLE. *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 814, 14 pp. Original research. Sn-Te alloys with up to 1% Te were prepared by first making a temper alloy by adding Te to Sn under borax and adding the temper alloy to Sn under charcoal. Tensile, Brinell and creep tests were carried out on machined chill-cast specimens and on rolled strips of alloys containing up to 0.1% Te. The effects of cold rolling and various heat treatments were studied. Up to 1% Te slightly improved Brinell hardness and tensile strength of Sn, but heat treatment of alloys did not produce permanently improved properties. Te-Sn alloys had a remarkable capacity for work hardening in the chill-cast state, but this was diminished when the ingots were annealed before deformation. Te considerably improved the creep strength, both in the cast and rolled conditions. The work-hardening properties of these alloys may form a valuable guide to their relative creep strength. Grain-size measurements were made after various mechanical and thermal treatments, and it was found that grain size has a marked effect on creep strength of these alloys. JLG (10b)

The Magnetic Properties of Cobalt-manganese-aluminum Alloys (Die magnetischen Eigenschaften der Kobalt-Mangan-Aluminium-Legierungen) W. KÖSTER & E. GEBHARDT. *Z. Metallkunde,* Vol. 30, Sept. 1938, pp. 286-90. Experimental. Measurements of the maximum magnetic moment were made throughout the α solid solution range in the Co-Mn-Al system, attaining a maximum of about 7,500 gauss. In general, the values are somewhat greater than for the same alloys containing Ni instead of Co. When a superstructure can exist, the Curie temperature is lowered as the degree of order increases in the solid solution alloys. Magnetic aging occurs in the α-γ, and to a less extent in the α-β Mn two-phase regions. GD (10b)

Tellurium Lead for Plating and Pickling Equipment. G. O. HIERS & G. A. STEERS. *Metal Ind., N. Y.,* Vol. 36, Dec. 1938, pp. 563-566. Practical. The addition of small amounts of Te to Pb gives increased fatigue resistance and resistance to corrosion. Te-Pb, when used in plating and pickling tanks, gives greater life than chemical Pb. Te-Pb has a finer structure and smoother surface, thus diminishing the possibility of pitting and local corrosion; resistance to corrosion fatigue is better. Stability of structure at elevated temperatures keeps down rapid corrosion. Te imparts work-hardening properties to Pb so that the alloy becomes strengthened when strained. This property is especially valuable for heating coils. CBJ (10b)

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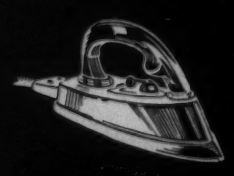

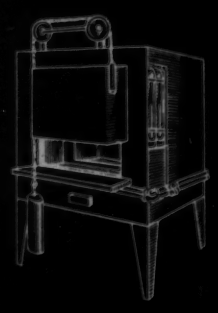

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Plastic Deformation of Lead, Copper and Aluminum under Static Compression. W. J. LYONS. *J. Applied Phys.*, Vol. 9, Oct. 1938, pp. 641-646. Experimental. A study was made of the effect of load duration in the plastic compression of small cylinders (usually 1.27 cm. height by 0.826 cm. diameter) of Pb, Cu and Al. This effect is important in the use of Pb "crushers" for measuring pressures. Static compression tests were made on Pb over 30-min. periods and under loads up to 109 kg. The time effect is greater at the higher loads and is greater for Pb than for Cu and Al. Under constant pressure the deformation-time relation is approximately linear. The data on Pb agree with results of Bogomolov and Kunin for pressures in the higher range, but an equation proposed by them does not hold in the lower range of pressures studied in this work. HFK (10b)

The Paramagnetism of Manganese (Sur la Paramagnétism du Manganese) A. SERRES. *J. Phys. Radium*, Vol. 9, Sept. 1938, pp. 377-380. Original research. Contradictions in previous literature are summarized. The experimenter employed vacuum-distilled Mn of 99.99% purity, the impurities being traces of Al, Fe, Co, Mg, Ag and P. Between —183° and +600° C. the paramagnetism of Mn varies with temperature only slightly and in a continuous manner. At low temperatures, the magnetization passes through a maximum. At elevated temperatures it seems to be directed towards a limit below 600° C. probably up to the temperature of the transformation of $\alpha \rightarrow \beta$. The anomaly in the specific heat found by Ashworth (*Proc. Roy. Soc.*, 1936, Vol. 48, p. 456) has no corresponding effect in the magnetization/temperature curve. EF (10b)

The Changes of the Modulus of Elasticity and the Damping Capacity during Deformation and Recrystallization of Brass (Die Änderung von Elastizitätsmodul und Dämpfung bei der Verformung und Rekristallisation von Messing) W. KÖSTER & K. ROSENTHAL. *Z. Metallkunde*, Vol. 30, Sept. 1938, pp. 345-348. Experimental. Deformation of a 72% Cu, 28% Zn brass lowered the modulus of elasticity. The original value was recovered in 2 steps on annealing, the first third occurring below the recrystallization temperature, the remainder of the recovery accompanying recrystallization. The modulus continues to increase during grain growth. The damping capacity is increased by deformation and this can be attributed to internal stresses. It returns to the normal value rapidly at room temperature, although the process is accelerated by heating. Recrystallization gives rise to another increase in the damping capacity. GD (10b)

The Mg-$MgCd_2$-Mg_5Tl_2 Region of the Ternary System Mg-Cd-Tl (Der Teilbereich Mg-$MgCd_2$-Mg_5Tl_2 des Dreistoffsystems Magnesium-Kadmium-Thallium) W. KÖSTER & E. WAGNER. *Z. Metallkunde*, Vol. 30, Sept. 1938, pp. 335-338. Experimental. The liquidus surface of the region was explored by thermal analysis, showing one quaternary reaction: Melt + Mg solid solution $\epsilon \rightleftarrows MgCd_2 + Mg_5Tl_2$, at about 320°. The homogeneity range of the ϵ phase was determined microscopically and found to extend to an alloy containing 45% Cd and 15% Tl. The hardness of alloys annealed at 350° C. for 24 hrs. and then quenched increased regularly with alloy additions. An alloy containing 35% Cd and 35% Tl showed considerable increase in hardness after aging at 250° C. The density of the ϵ phase was decreased by alloy additions. The resistance to atmospheric corrosion is increased by addition of the alloying elements to Mg, but resistance to corrosion by conductivity water is decreased. GD (10b)

Embrittlement of Tin at Elevated Temperatures and its Relation to Impurities. C. E. HOMER & H PLUMMER (Internatl. Tin Res. & Development Council) *J. Inst. Metals*, Vol. 64, 1938, Advance Copy No. 820, 32 pp. Original research. A simple bending test with the Sn specimen in oil, and maintained at any desired temperature, was used for determining brittleness. The brittleness of Sn below its melting point resulted from impurities. Moreover, by carrying out the test on a series of alloys over a range of temperature, solidus curves of Sn-rich alloys could be determined. Curves for Sn with Pb, Cu, Bi, Cd, Zn and Ag were determined. Sb, As and Fe did not make Sn brittle below its melting point. The influence of 2 or more elements on brittleness was also studied. Previous literature on the supposed high-temperature form of Sn was reviewed, and it was concluded that there is no such modification. Where transformations at elevated temperatures were reported, these were probably caused by impurities and were not real allotropic transformations. JLG (10b)

10c. Effect of Temperature

H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

The Creep of Metals Under Static and Repeated Stresses. F. C. LEA. *Foundry Trade J.*, Vol. 59, Oct. 6, 1938, pp. 251-252. Creep occurs and may lead to fracture above 300° C. under static stresses much less than required for failure under rapid loading. For pressure vessels, the allowable rate of creep is obtained at a stress about ½ the tensile strength at 300° C. and at 500° C. at less than ⅓ the tensile strength. In designing equipment for high temperature service, the expected life and maximum allowable strain dictates the working stress. Structural stability as well as creep strength of the steels must be considered. Under repeated stress at elevated temperatures, a slow cycle such as 2 to 3 a minute produces creep similar to that under a steady load. Relative merits of steels for a new problem can be approximately obtained by short-time tests, but as yet no short-time test will indicate the final rate of creep to which after a certain time at a particular stress the metal will settle down. HCC + AIK (10c)

Growth of Cast Iron for Piston Rings at Temperatures up to 700° C. (Wachsen von Gusseisen für Kolbenringe bei Temperaturen bis 700°) F. BOLLENRATH & K. BUNGARDT. *Stahl u. Eisen*, Vol. 58, Oct. 13, 1938, pp. 1111-1113. Original research. The growth on prolonged heating of several piston ring cast irons of about 3.8% C, 3% Si, 0.8% Mn, 0.7-1% P, 0.1-0.5% Cr and 0.3-0.8% Mo was determined with a Leitz dilatometer. The rate of growth reaches a maximum after a certain time at temperature, this time being shorter for higher temperatures; with further heating the rate of growth then diminishes. At the low temperature of 450° C. observable increase in length was only noticed after 500 hrs. heating, and there was doubt whether this was really growth or drift in the measurement. The temperature range where growth began after a heating period of 700 hrs. was about 450° C. SE (10c)

Bi-metals for Temperature Controls. HOWARD D. MATTHEWS. *Elec. Mfg.*, Vol. 22, Sept. 1938, pp. 35-37. Review. For soldered bi-metals, the maximum usable temperature is 600° F. Welded bi-metal strips are designed for use above this temperature. Steel alloys with Cr, Ni and Mn give maximum expansion through a specific temperature range and may be utilized up to 1200° F. In general, a 40-50% Ni steel is used on the low expansion side above 500° F. For maximum sensitivity, there has been little improvement over the invar-brass combination. Author gives a number of useful formulas. FHC (10c)

11 · CORROSION AND WEAR

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Structure of Iron Oxides Obtained at Moderate Temperatures M. S. BORUSHKO & N. F. LASHKO. *Zhur. fiz. khim.*, Vol. 11, May 1938, pp. 737-743. In Russian. Original research. The oxidation products of 7 varieties of iron and steel subjected to corrosion or severe plastic deformation in various media, were analyzed by the Debye-Scherrer-Hall X-ray method in a pin-hole camera using Fe and Cu radiation. The oxidation products were analyzed on the samples themselves or in the form of powder scraped from their surface. Materials tested included Armco Fe, boiler plate, 0.8% Cu steel plate, Cr-Cu steel, and rail steel. The media were sea water, river water, flue gases, air, caustic soda and nitric acid solutions. Both the medium and material were usually changed with each test, so that conclusions as to relative corrodibility cannot be drawn. The predominant constituent of the oxides obtained at room temperature was a ferromagnetic Fe oxide, the X-ray data pointing to γ Fe_2O_3 rather than Fe_3O_4. With Armco Fe in flue gases only paramagnetic α Fe_2O_3 was formed, it is possible that ferromagnetic γ Fe_2O_3 was formed primarily, which, being unstable at the higher temperatures of the test (210° to 275° C.), secondarily transformed into the paramagnetic modification. The absence of oxidation products on the Cu-steel plate exposed to caustic soda solution is probably due to the formation of a thin protective film by the action of the NaOH solution. The surface of the rail steel was crushed by rolling 2 cylindrical specimens over each other in the Amsler machine. Blue scales formed and were found to contain a greater proportion of α Fe_2O_3, a smaller amount of γ Fe_2O_3, and no FeO. A small amount of crystalline hydroxides was also present, their crystallites being larger than those of γ Fe_2O_3. In scraping the oxide powder from the deformed specimens, particles of metallic Fe were apparently also removed, whose high-index interference lines seemed to be more intensive than the low-index ones. This fact possibly indicates the presence of stresses of a third kind—stresses determined from the relation between the intensities of different-indexed lines which are connected with the deformation of the crystal lattice. The interference lines of the oxides and hydroxides exhibited no anomalies, so that their crystal lattice may be assumed to have undergone no perceptible deformation. ORS (11)

Corrosion and Erosion in River and Harbor Structures. FRED DIEFFENBACH (U. S. War Dept.) *Ind. Eng. Chem.*, Ind. Ed., Vol. 30, Sept. 1938, pp. 1014-1020. Practical investigation. Very severe corrosion-erosion conditions exist in the Monongahela River as the result of highly acid sand-bearing water. The condition is best corrected in most cases by use of corrosion-resisting materials, such as fortified paints or enamels, corrosion-resisting iron alloys, alloy cast irons, Ni-Cu alloy (Monel), etc. Detailed specifications are given for a superior corrosion-erosion resisting paint for Fe and steel structures in the River. An austenitic 2-4% Mo, 16-20% Cr, 7-14% Ni steel, which is not only corrosion resistant but resists erosion because of its work hardenability is recommended for steel structures for this service; a Mo-bearing, 0.12% C, 12-15% Cr steel may be used where the uniform high hardness available by heat treatment is desired. For bearings lubricated only by the river water a bronze containing 80% Cu, 10% Sn, 10% Pb and 0.30-0.50% P has given good results. A good boiler compound for treating river water for boiler use contains 61% sodium carbonate, 18% sodium phosphate monohydrate, 13% sodium hydroxide and 8% tannates. Method and equipment for making accelerated tests on materials are included. MEH (11)

Relation of Soil Properties to Corrosion of Buried Steel. WALTER F. ROGERS (Gulf Oil Corp.) *Ind. Eng. Chem.*, Vol. 30, Oct. 1938, pp. 1181-1188. Research. Studies were made on the relation of soil volume-water content, soil pH, and soil electrical resistivity to the corrosion of buried steel pipe. The importance of these factors are shown in data developed from actual tests in the laboratory and in the field. While both the electrical resistivity and soil pH have some effect on the soil corrosion rate, the governing factor is the soil volume-water content. 16 references. MEH (11)

Anodic and Ordinary Corrosion of Ferrous Metals in Various Acids. RAYMOND R. ROGERS & EDGAR BLOOM, JR. (Columbia Univ.) *Trans. Electrochem. Soc.*, Vol. 74, 1938, Preprint No. 22, 11 pp. Original research. The corrosion of the following metals was determined in 3-12 N. solutions of HCl, H_2SO_4, HNO_3 and H_3PO_4, at room temperature and at 60° C.: Cold rolled steel; 18-8 Cr-Ni steel; 14% Cr iron; Silcrome RA (16% Cr, 1.25% Cu, 1.25% Si); Duriron (14.5% Si, 0.8% C, 0.35% Mn); and Durichlor (14.5% Si, 3% Mo). Most of the test specimens were sheet metal 2 in. x 1 in. The rate of corrosion was expressed as the loss of weight of a specimen in mg./min. 2 corrosion rates were measured: (1) The test specimen was simply immersed in the corroding solution; (2) the specimen was made anodic with a current density of 0.5 amp./in.^{2} Duriron and Durichlor were corroded in HCl, H_2SO_4, and HNO_3 less than the other metals, but were corroded more in H_3PO_4. The 14% Cr iron was corroded the most rapidly of the metals in HCl and H_2SO_4. With the exception of steel, all the metals resisted attack by HNO_3 on simple immersion, but all metals were attacked by anodic corrosion. Durichlor was slightly more resistant than Duriron to corrosion on simple immersion, but was slightly less resistant to corrosion on anodic treatment. AB (11)

Hydrofluoric-acid Corrosion; Where Monel Metal Has Proved Its Value. *Chem. Trade J.*, Vol. 103, Nov. 4, 1938, p. 416. Descriptive. Outstanding use of Monel metal in contact with HF is for tanks and trays for etching and frosting glassware. Tests in a storage tank holding 40-60% HF at 20°-25° C. showed corrosion rate of 0.003 in. penetration/yr. continuous exposure. In 48% acid at 80° C., rate was 0.015 in./yr. exposed for 8 hrs./day, 365 days/yr. In 40% acid at 55° C., rate was 0.009 in./yr. continuous exposure. A tank has been in service holding concentrated HF stock etching solution for 15 yrs. with no signs of destructive attack. Specimens exposed in a duct carrying away HF fumes showed corrosion rates of 0.00002-0.00003 in./yr. continuous exposure. Cups handling paste of 100 oz. HF, 99 oz. (NH_4) HF_2, 66 oz. $(NH_4)_2$ CO_3, and 21 oz. NH_4Cl showed rate of 0.008-0.009 in./yr. continuous use. Monel metal is successfully used for equipment for pickling cast-Fe with HF. Tests in a 6% solution at 80° C., showed corrosion rate of 0.0006 in./yr. continuous exposure. In 10% acid at 10°-20° C., rate was 0.000002 in./yr continuous exposure. In this test, cast-Fe rate was nearly ¼ in./yr. Monel metal equipment is used in laundries for acid fluoride sours with no evidence of attack. It is also used in electrolytic refining of Pb, where H_2SiF_6 is the important corrosive. MS (11)

The Tarnishing of Silver and Silver Alloys and Its Prevention. L. E. PRICE & G. J. THOMAS. *J. Inst. Metals*, Vol. 63, 1938, Advance Copy No. 812, 29 pp. Original research. Seventy thousand specimens of pure Ag and of 100 of its alloys were exposed for periods up to 1 yr. in 15 different locations, mainly in living rooms and kitchens. The tarnishing of these specimens was followed by observation of the tarnish colors produced, and by an electrometric method. A theory was developed that showed the factors involved in tarnish resistance. It explains many results and has indicated that other alloys (*e.g.* those containing Al) which have not previously been found to be tarnish-resistant, become tarnish resistant when the alloy is heated under conditions that only the Al is oxidized, giving rise to an invisible film of pure Al_2O_3. Tarnish-resistant films cannot be formed by heating these alloys in air, owing to the fact that both Ag and its alloy constituents oxidize simultaneously. Optimum results can be expected only with pure films of such oxides as Al_2O_3 and Be_2O_3 when free from Ag oxide. Two methods were developed for the formation of such films: (1) Selective oxidation of Al or Be in Ag-base alloys by heating in H containing 0.1 mm. partial pressure of H_2O, to give a film of pure alumina or beryllia, and (2) superimposing transparent, cathodically-deposited films of these oxides on pure Ag and its alloys. Such oxide films are found to be highly protective against tarnishing. JLG (11)

The Attack of Hot Gases on Steel. E. HOUDREMONT & G. BANDEL. *Foundry Trade J.*, Vol. 59, 1938, Sept. 15, pp. 195-196; Sept. 22, 1938, pp. 220, 222. Review. So far as scaling is concerned, the principal alloying elements in steel may be divided into 2 groups: Those with a greater and those with a lower affinity for O_2 than has Fe itself. To the former group belong Al, Si, Cr, Mn, Zr, Ti, V and N, and to the latter Cu, Ni, Mo and Co. High scaling resistance depends on the formation of an oxide film denser than the coating formed on Fe alone, and which will be adherent and will impede the further progress of scaling; a self-healing film is ideal. Very important also are the impedance offered to the diffusion of O_2 or other active gas toward the underlying metal on one hand, and a similar impedance to the outward diffusion of the alloy through the oxide on the other. These factors are related, as is the sintering temperature of the oxide film, to the melting point of the oxide or silicate formed and to the melting point of the most fusible constituent of the scale. In addition to Al and Si as useful additions to Cr steels, Ni is also used to a very large extent; Ni improves the scaling properties of pure Fe only very slightly, but results in a great improvement when it is associated with Cr. In recent German installations a steel with about 0.9% Cr, 0.5% Mo, and 0.5% Si has been successfully used. The disparity between the rates of scaling in air and steam is difficult to explain; a more porous scale is formed when steam is the attacking atmosphere. It is possible that H_2 is liberated explosively and may render the scale porous or alter its chemical composition in some way. The alloying elements giving the greatest protection in air also increase the resistance to attack by sulphur dioxide. Scaling properties are related to the metallurgical history of the steel. Because all the heat-resisting steels contain elements with a great affinity for O_2, the danger is always present that these elements oxidize partially in the manufacturing process and may give rise to oxide segregation.
AIK (11)

The Electrode Potentials of Metals and Alloys in Copper Nitrate Solution. YOICHI YAMAMOTO. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, *Abstract Suppl.*, pp. 37-38. In English. Original research. The single electrode potentials of 21 pure metals, 2 non-metals and 6 alloys in $Cu(NO_3)_2$ solution of 2-20% were determined by the valve potentiometer after 20 min. immersion. The results obtained in the weakest and strongest solution tested were as follows: *In 2% $Cu(NO_3)_2$:* Mg → Zn → Mn → Cd → Pb → Sn → Fe → Co → high C steel → Al → Sb → Bi → Si → brass → Cu → 80/20 Ni-Cr → Monel metal → Ni → Mo → W → 13% Cr stainless steel → 18/8 → Ta → Au → Ag → Cr → Hg → C → Pt. *In the 20% $Cu(NO_3)_2$ solution:* Mg → Zn → Mn → Cd → Sn → Pb → Al → Co → high C steel → Fe → Bi → Sb → brass → Cu → Monel metal → Ni → Mo → Si → Ta → 18/8 → 13% Cr stainless steel → 80/20 Ni-Cr → Ag → Hg → Cr → Au → W → Pt → C. The deposition of black compounds of Cu was observed on the surface of Mg, Zn, Cd (only below 8% $Cu(NO_3)_2$), Pb (only at 2% $Cu(NO_3)_2$), and the deposition of metallic Cu occurred on the surface of Cd (above 14% $Cu(NO_3)_2$), Pb (above 8% $Cu(NO_3)_2$), Fe, Co, Sb and Bi (above 14% $Cu(NO_3)_2$). Sn was attacked by copper nitrate solution, but Cu was not deposited; a white substance was formed on the surface. The other metals and alloys were scarcely attacked after 20 min. immersion.
EF (11)

The Phenomena of Abnormal Corrosion in Condenser Tubes. Part II. KURAZO FUKAGAWA & KEN-ITIRO KAMIYAMA. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1377-1408. In English. Original research. The following 2 types of abnormal corrosion in condenser tubes were studied: (a) The inlet and outlet portions are more vigorously corroded and eroded than the other portions, (b) the upper wall surface is more severely corroded than the lower wall surface. Tubes of various commercial condenser tube materials (analyses not given) were studied at 27° C., the flowing solution having the critical speed of 200 cm./sec. After 278-1079 hrs., the tubes showed the above types of attack. The majority of the tubes were made of Al-brass, which shows great differences in corrosion resistance, but were superior to Cu-Ni. 19 photographs. For previous work, see also *Metals and Alloys,* Vol. 7, Sept. 1936, p. MA 469 R/4; Vol. 8, Jan. 1937, p. MA 42 R/8.
EF (11)

Absorption of Hydrochloric Acid Gas with Tantalum Equipment. F. L. HUNTER (Fansteel Metallurgical Corp.) *Ind. Eng. Chem.*, Vol. 30, Nov. 1938, pp. 1214-1219. Descriptive. Pure Ta is completely inert to action of HCl up to 630° F. Besides being corrosion-proof, Ta has high thermal conductivity, and, with HCl, has remarkably good heat-transfer characteristics. Because of the high cost of the metal, the new unit for absorption departs from conventional design and makes the advantages of an acid-inert system available at a cost comparable with, or less than, the installation cost of conventional systems. Diagrams for the absorption system are given.
MEH (11)

Research on Thin Layers of Tin and other Metals. V. The Corrosion of Tin by Dilute Organic Acids. J. A. NINCK-BLOCK-KITS VAN HEYNINGEN & D. A. WAS. *Proc. Koninkl. Akad. Wetenschappen Amsterdam,* Vol. 4, Sept. 1938, pp. 717-724. In English. Original research. Continuation of previous work. (For parts I, II, III and IV, see also *Metals and Alloys,* Vol. 9, Aug. 1938, p. MA 515 L/7.) Thin layers of Sn made on glass by high vacuum evaporation were exposed to weak solutions of citric, lactic, benzoic and propionic acids at room temperature. The corrosive effects were studied by an optical method (See part II). The quantities of dissolved metal in 10^{-6} g./cm.^{2} are plotted against time in min. for various concentrations. The character of the curves is essentially the same as that previously found for corrosion by oils. After some time, the first violent attack is retarded by the formation of a film of reaction products, which decreases the diffusion of the acid towards the metal surface. Nearly constant corrosion velocities were found for high concentrations. After some time, a stationary state is reached in all cases. The sequence of the corrosion attack is: Citric, lactic, propionic and benzoic acids. This falls in line with the relative values of the dissociation constants of these acids.
EF (11)

The Durability of Cast Iron Tanks for the Chemical Industry (Ueber die Haltbarkeit gusseiserner Kessel für die chemische industrie) A. GEISSEL. *Giesserei,* Vol. 25, Nov. 4, 1938, pp. 564-566. The composition of acid- and alkali-resisting cast Fe is discussed, and the factors determining the attack are explained. Alkali-resisting cast fe has preferably 3.3-3.5% C, 1.2-1.4% Si, 0.3-0.4% Mn, not over 0.3% P and not over 0.08% S; the lower Mn the better, as high Mn iron often gives a brownish color to the liquids in the tank. A correct ratio of graphite to combined C is important for the life of the casting. The higher the combined C the longer the life; a few tables of practical cases are given to illustrate this point.
Ha (11)

Metals in Wine-making (Die Metalle in der Weinbereitung) R. W. MÜLLER. *Korrosion u. Metallschutz,* Vol. 14, Dec. 1938, pp. 385-388. Experimental. The effect of metals on color, taste and aroma of wines and the corrosive effect of wines on metals were investigated, as replacement of the usually-employed wooden equipment by metal would save space and maintenance (leakages). Of the metals tested, Inconel and 18/8 steel were practically unattacked. The 18/8 steel, however, should not be used for closed fermentation tanks and mixers. Ni can be used for pipe lines, bottle-filling tanks, mixers and grape-juice containers, and also for open fermentation tanks. Monel metal and Cu should be used only for equipment in which the liquid does not remain long. Sn is the least suitable metal for wine cellar equipment; it is most strongly corroded in contact with red-wines. Pure Fe or steel can not be employed. The max. metal contents in wine if color, taste and aroma are to be unaffected, are: Fe, 1; Sn, 1; Cr, 15; Cu, 60; Al, 100; Zn, 200; and Ni, 200 mg./l. Solubility tables are given.
Ha (11)

Oxidation of Cu Alloys at High Temperatures. HIDEO NISHIMURA. *Suiyokwai-Shi,* Vol. 9, Oct. 1938, pp. 655-664. In Japanese. Original research. Cu alloys containing Al, As, Mn, Ni, Si, Sn and Zn in the α range were heated in an oxidizing atmosphere at 700°. The alloys containing more than 3% Al were the most resistant to oxidation at the higher temperatures, probably because of the formation of a compact surface film of Al_2O_3. The effects of As, Cr, Fe, Mn, Ni and Ti on the oxidation of the Cu alloys containing 8% and 10% Al were studied. The addition of Fe, As, or Ni was not harmful to the oxidation resistance of such Cu-Al alloys, but Mn and Si show a tendency to increase the oxidation. Addition of Cr is without effect on oxidation resistance, although the alloy is prone to much segregation.
HN (11)

Atmospheric Oxidation of Amalgamated Aluminum (Ueber die Quecksilberanfälligkeit des Aluminiums) H. LICHTENBERG. *Z. anorg. allgem. Chem.*, Vol. 239, Sept. 3, 1938, pp. 189-196. Research. The rate of reaction of amalgamated Al with air obeys the equation $G_1 = k\sqrt{t}$, where G_1 is the gain of weight in air of the activated Al, k a constant and t the time. A relation was noted between k and the purity of the Al. With increasing content of Cu, Fe and Si in Al, the rate of oxidation of the activated metal decreases.
HFK (11)

Dissolution of Aluminum in Pure Soda Solutions, and in those Containing Silicates (Die Auflösung von Aluminium in reinen und in mit Wasserglass versetzten Sodalösungen) H. LICHTENBERG & K. GEIER. *Korrosion u. Metallschutz,* Vol. 14, Oct./Nov. 1938, pp. 365-367. Research. The dissolution of pure Al sheets in soda solutions depends on the concentration of the attacking solution; even weak solutions attack strongly because of their high OH-ion concentration. The velocity of dissolution decreases with increasing length of time of the tests; this is explained by the formation of protective layers. An addition of 0.025% SiO_2 in the form of sodium silicate protects Al from dissolving in soda solutions.
Ha (11)

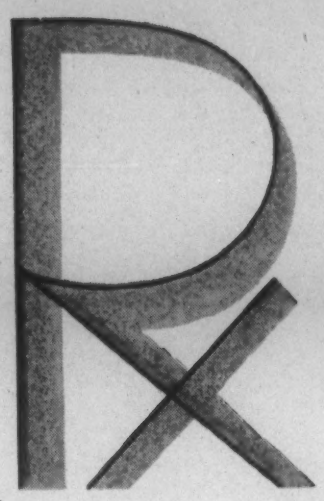
Some Observations on the Passivity of Stainless Steels. J. N. OSTROFSKY (Rustless Iron & Steel Corp.) *Am. Soc. Metals,* Preprint No. 8, 1938, 8 pp. Research. Treatment of stainless steels with warm 20-40% nitric acid for 1 hr. or more as a final processing step has long been practiced in order to remove surface contamination and promote formation of a surface conditions or passivity which serves to retard corrosion. Experiments indicate that treatment of stainless steels (0.10% C, 15-17% Cr) with boiling 0.1-0.5% nitric acid subsequent to pickling in the 20-40% acid produces a more durable passivity in the following solutions: (1) boiling 4% acetic acid containing 1% sodium chloride, (2) boiling solution containing 3 parts sulphuric and 1 part nitric acid diluted to a total acidity of 0.5% figured as sulphuric acid, (3) 25% by weight sulphuric acid. The weak nitric acid solution readily attacks steels having 13% or less Cr. These steels may be passivated with good results by treatment with a boiling solution containing 0.50% nitric acid and 0.50% potassium dichromate. Passivity to a 4% salt spray was most effective when developed by boiling in 0.50-5% dichromate solution. Good adherence of Zn and Cu plates on stainless steel was obtained by cleansing and activating in nitric-hydrofluoric acid mixtures. HLW (11)

Contribution to the Theory of the Tarnishing Process. III (Beitrag zur Theorie des Anlaufvorganges. III) CARL WAGNER & KARL GRÜNEWALD. *Z. physik. Chem.,* Abt. B, Vol. 40, Aug. 1938, pp. 455-475. Original research. Continuing the research on the mechanism of surface oxidation of heavy metals (*Metals and Alloys,* Vol. 5, Jan. 1934, p. MA 5; *Z. physik Chem.,* Abt. B, Vol. 32, 1936, p. 447), the rate of oxidation of Zn, Cu, Ni and of Ni-Au alloys with 0, 25, 50, 75 and 100 atomic % Au, as depending on the O_2 pressure, was determined. Rods or strips were kept from one to several days in a slow current of pure O_2 or of N_2 with 2.19% O_2, at 5-400° C. The rate of oxidation was measured by the increase in weight of the specimens. The rate of oxidation of Zn to ZnO does not depend on the O_2 pressure. The rate of oxidation of Cu to Cu_2O increases with the O_2 pressure. The rate of oxidation of Ni to NiO increases with the O_2 pressure. A graphic method for separate determination of the rates of the phase-boundary reactions and the diffusion processes is described. The rate of oxidation of some Ni-Au alloys is considerably greater than that of pure Ni. It must be assumed that the scale formed on these alloys is not completely sound, so that some diffusion of O_2 molecules through the pores can take place. ORS (11)

Black Stain on Aluminum. *Light Metals,* Vol. 1, Dec. 1938, p. 381. Discussion. The recent German paper on black stains on Al (see *Metals and Alloys,* Vol. 9, Dec. 1938, p. 737 R/9) is discussed with particular reference to the optics involved. Finely divided metal is a very poor reflector of light, especially when the particle size of the powder approaches the wave length of the incident light. Hence, if a layer of essentially colloidal Al is formed on Al kitchen utensils owing to the action of hot tap water, blackening may be accounted for on this basis. Another and alternative theory, advocated by the present author, assumes that the "Beilby layer" of the polished utensils is partially removed by the mild corroding media, thus exposing the underlying crystalline metal and causing a roughened surface. AUS (11)

The Mechanism of Corrosion for Hydrogen-displacing Metals (Mechanismus der Korrosion wasserzersetzender Metalle) E. PLANK & A. URMANCZY. *Z. anorg. allgem. Chem.,* Vol. 238, June 24, 1938, pp. 51-64. Corrosion theory and experimental data. The speeds of solution of Tl in HCl, HNO_3 and H_2SO_4 solutions of various concentrations were measured and used to test Urmanczy's theory of corrosion based on the Nernst and Brunner theory of diffusion. The theory predicts those acid concentrations at which the speed of solution of the metal will be a maximum. These were found to be in good agreement with experimentally determined values. The effect of speed of rotation on the corrosion of Tl disks was studied. See also *Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 737 R/1. HFK (11)

Corrosion and Formation of Protective Layers by Water Flowing in Pipes (Korrosion und Schutzschichtbildung durch Leitungswasser) J. KOOIJMANS. *Gas- u. Wasserfach,* Vol. 81, Aug. 20, 1938, pp. 611-615; Aug. 27, 1938, pp. 628-633. The content of C, CO_2 and bicarbonates in water determines the rate of corrosion in Fe water pipes. Experiments to find the conditions of forming a protective layer with different temperatures and compositions of water are described in detail. The Ca-CO_2 equilibrium, which prevents corrosion, is disturbed by the organic substances always present in water. The rust-protective layer formed by lime consists of a crystalline precipitate $CaCO_3$ and $Fe(OH)_3$; the amount of Ca is about 1/10 that of Fe. $CaCO_3$ is precipitated by the discharge of H-ions; this gradually increases the alkalinity of the water which, in turn, increases the solubility of Fe, especially in soft waters. The mechanism of, and the chemical reactions leading to, the formation of the protective layer are explained in full. 9 references. Ha (11)



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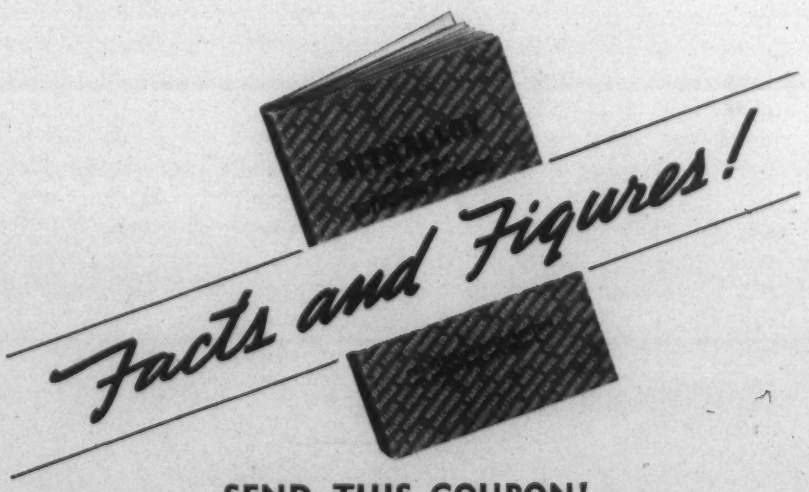

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books

Dust Removal and Ventilation Problems in Industry

(Entstaubungs-und Lüftungsfragen in der Werkstatt)

Roland Nagel

VDI-Verlag, Berlin, 1938. Paper, 5¾ x 8¼ in., 42 pages. Price 2 RM.

This little book is evidently intended to inspire the industrial superintendent to transform his factory into a dust-free, well-aired workshop of the "model plant" variety. In his preface and throughout the book the author persistently stresses one general thesis, with which we are in full accord, and which industry may some day need no pressing to accept: Dust removal and adequate ventilation are not only essential in certain work from the humane or social viewpoint, but they pay real dividends in more efficient production, better quality of product, lower compensation and lost time charges, reduced explosion hazards and therefore lower insurance rates, decreased janitoring waste, or—most important of all to certain industries—the recovery of valuable material that can be re-used or sold as a by-product.

The general phases of the subject—types of processes, equipment and applications—are treated in this book, and no attempt is made to cover the details of exhaust and ventilating system design. A very large number of the existing and potential applications of air-cleaning and dust-removal systems are in the metallurgical industries, as is shown by examining the illustrations that make up a 14-page appendix to the book. Applications are illustrated for metal grinding and polishing, painting and lacquering, sandblasting, pickling and tin-melting, and many others are discussed in the text. It is, on the whole, an interesting little book that may offer to the metallurgical engineer in charge of plant operations a few new ideas for applying dust-removal and ventilation systems.—FRED P. PETERS.

Metallographic Atlas

(Atlas Metallographicus) Volume 2, Parts 5 and 6

H. Hanemann and A. Schrader

Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, 1939. Paper, 7¾ x 11¼ in., 112 pages. Price 18.25 RM.

The structure of cast iron and the corresponding properties are illustrated and discussed in respect to composition and section, with attention also given to piston rings and centrifugal pipe. Chilled edges are also discussed.

The micrographs, as in the parts previously issued, are superb. The structures selected are so varied that one may usually be found that will closely resemble most of the specimens the metallographer has to deal with. It would often suffice for one's own records to note that a structure is as shown in a certain micro in *Atlas Metallographicus*.

Very little knowledge of German is needed to use the Atlas, as it consists primarily of the micros and tables describing them, so that this is more useful to the average American metallurgical engineer than the general run of German publications.—H. W. GILLETT.

Soil Corrosion and Pipe Line Protection

Scott Ewing

American Gas Assoc., New York, 1938. Cloth, 6¼ x 9½ in., 277 pages. Price $2.50.

The soil corrosion work that has been carried on cooperatively for many years by the Bureau of Standards, the American Gas Association, and the American Petroleum Institute has been covered by a multitude of progress reports. The owners of pipe lines and the producers of pipe have kept abreast of these reports as they came out, but even they, as well as those with less knowledge of the progress reports, will appreciate this summary, written by one who has been intimately connected with the work, in which the conclusions that the work has long pointed to, are rather definitely phrased.

Not only the technical matters, details of the extensive tests, laboratory methods for evaluating soil corrosiveness and field methods for mapping soil types and evaluating the condition of pipe lines, but also the economics of bare versus protected pipe and the engineering methods for coating pipe at the mill and in the field, and for protection by applied voltage, and by zinc anodes, are concisely dealt with.

On the whole, the soil is more of a variable than the pipe. Some soils are so innocuous that there is no need for protection, others so corrosive that it pays to take extreme precautions, but it doesn't make a whole lot of difference what ferrous material the pipe is made of; broadly speaking, they act much alike when buried in the same soil.

From a fine-haired viewpoint, the greater wall thickness of cast iron pipe plus the ability of cast iron to build up a tight crust even though corroded gives cast iron a long life for lines where the pressure is not too high. That wrought iron sometimes gives a somewhat better account of itself than would be expected from the broad statement that all ferrous materials act alike is explained on the basis that in these cases the soil is such that it discriminates between low and high phosphorus, and that the high P in the ferrite, not the slag, is the beneficial agent. In distinction to atmospheric corrosion, where the Cu + P combination shines, the Cu content makes little difference in soils.

Peculiarities in the behavior of replacement pipe, especially in service lines into houses, are ascribed to the fact that when a new pipe is connected into an old line, the new pipe usually becomes anodic and protects the old at its own expense. City soils are more variable and their behavior less predictable than soils not made by filling because the city streets are made up of everything "from bottles to bed springs."

Ordinary paints and thin bituminous coatings are useless, as they have pinholes and don't prevent pitting; a coating has to be uniform. Thick, perfect, wrapped, or otherwise reinforced, asphalt coats are useful, and concrete coats are good where the soil is low in soluble salts, but such coatings have to be applied by proper methods. Electrolytic protection, by applying current through copper oxide rectifiers, from wind-driven generators, or by zinc anodes connected in at frequent intervals, is called for in bad soils. Choice of pipe coatings or of no coating will depend on whether the coating alone is relied upon or whether electrolytic protection is to be applied.

The progress reports have been prepared with a lot of ifs and ands. This summary, while discussing variables and their effect in modifying general statements, does make positive and definite statements that have direct applicability to the metallurgical and engineering problems involved.—H. W. GILLETT.

Practical Methods of Material Testing

(Werkstoffprüfung)

Fredo Grahl

Carl Hanser Verlag, Munich, 1938. Paper, 6 x 8¼ in., 79 pages. Price 1.50 RM.

This pamphlet, No. 6 in the "Werkstattkniffe" series, starts with the usual description of specimens and methods for tensile testing, followed by compression, transverse, shear, torsion, notched impact, and hardness tests. Technical bend tests, those for strength of welds, repeated bend, Erichsen and wedge drawing tests are then described. Spark testing is illustrated by a score of photos. Deep etching and evaluation of a few plated coatings complete the topics.

The material is available elsewhere, but this is a convenient compilation. It deals almost solely with metals.—H. W. GILLETT.

Design of Industrial Exhaust Systems

John L. Alden

Industrial Press, New York, 1939. Cloth, 5¾ x 8¾ in., 220 pages. Price $3.00.

In the preface, the author states, "Industry . . . is well informed of the need for exhaust sanitation. It is not well informed as to how best to satisfy that need. The purpose of this book is to tell the engineer how to design and build or how to buy an exhaust system that will adequately and economically perform the functions prescribed by the industrial hygiene expert or by law." This purpose is filled by confining the discussion to the flow of fluids through hoods, pipes, and dust separators with only a short chapter devoted to exhaust fans.

Chapter I on the flow of fluids presents clearly and concisely the fundamentals of the subject. The use of nomograms is introduced here and continued throughout the book. In Chapter II on hood-forms the importance of their design is stressed by showing velocity contours and flow directional lines about the face of typical hoods. Examples of proper types of hoods for various kinds of machinery are given.

Chapter III discusses air flow through hoods and stresses the importance of the design of the hood face in determining the entry coefficients and thus the flow of air with a given suction.

Chapter IV gives much information on pipe resistance available generally elsewhere but also much assembled from scattered sources. In Chapter V, the procedure to be followed in piping design is demonstrated by a practical example.

The author points out in Chapter VI on dust separators that less significance should be attached to the efficiency of a separator than to the dust content of the cleaned air. He presents, insofar as available, the fundamental principles underlying the design of gravity settling chambers and cyclone separators.

Brief chapters on low-pressure conveyors, on centrifugal fans, and on structural details and system planning follow and the book concludes with chapter X on field measurements and their interpretation. This includes practical suggestions on types of manometers, static and pilot tubes and flow direction finders and their use. The book closes with an apparently adequate index but a table of contents at the front was, strangely, omitted.

All in all the book will serve as a valuable aid to the engineer in laying out the design of an exhaust system or in checking to correct the faults of a system that was built and not designed.—RALPH A. SHERMAN.

Carbon and Alloy Steels *(Gli acciai communi e speciali)*

G. Guzzoni

U. Hoepli, Milan, 1939. 6¾ x 9¾ in., 666 pages. Price 120 L.

The second edition has been entirely rewritten and considerably enlarged, by some 200 pages and 175 figures. The section on alloy constructional steels has been tripled and that on corrosion and heat resistant steels doubled. The selected bibliographies have been brought through 1938. Information from Italian, English, French, German, and American sources, with now and then a bit from Russian or Japanese, is worked into a unified whole.

Some of the features of difference from the 1932 edition are: Inclusion of the solubility of C in ferrite in the Fe-C diagram, discussion of grain size with A.S.T.M. charts, of Mo high speed and Cr-Mn stainless, use of the S curve, emphasis on notches in fatigue, and description of precipitation hardening. Many other modern facts or points of view get brief mention. In general the treatment is well balanced; however the creep data given are useless because they are based on short times and large deformation, accelerated fatigue tests are mentioned as though they were of value, and the discussions of low alloy, high yield strength steels and of controlled atmospheres are so cursory as to suggest that they have not been given due attention in Italy.

The point of view is that of the physical metallurgist, melting and other production factors being only incidentally dealt with. Cast steels are given practically no attention. Those topics that are covered are, on the whole, well handled. Since recent books of similar scope are available in English, the chief value to an English speaking reader lies in the selected bibliographies which list outstanding publications in the world metallurgical literature on the various topics.

The type, paper, micrographs, and the book-making in general, are excellent.—H. W. GILLETT.

Metallurgical Plants. Volume I. Extraction and Production *(Die Hüttenwerksanlagen. Band I. Anlagen zur Gewinnung und Erzeugung der Werkstoffe)*

Hubert Hoff & Heinrich Netz

Julius Springer Verlag, Berlin, 1938. Paper, 8 x 11 in., 468 pages. Price 63 RM.

This book is intended for metallurgical and mechanical engineers and others interested in the design of metallurgical plants. The present volume deals mostly with furnaces and general plant equipment used for the production of raw materials, while the second volume will pertain to equipment for the working and shaping of metals by rolling, forging, extruding and drawing.

Only 12 introductory pages consider the economics of selecting the location of a new plant, transportation means, and structural viewpoints. The book is really a text-book on furnaces, and it may not therefore be surprising that some 70 pages are devoted to furnaces employed in the ceramic, glass, lime, dolomite and cement industries, making it an "almost complete treatise of industrial furnaces." Fuels, combustion problems, furnace construction materials, coking ovens and gas generators are dealt with in 127 pages, and 10 pages are devoted to roasting plants. Furnaces used in the production of iron and steel get 100 pages, while 80 pages are given to non-ferrous metallurgical furnaces. In view of their importance, Cu, Pb, Zn, Al, Sn furnaces are more thoroughly taken up, while furnaces used for the production of Bi, Sb, Ni, Hg, Mg, Ag, Au and Pt are treated more or less sketchily. A 35-page chapter deals with foundry equipment and 15 pages describe cleaning of waste gases. In view of the high price of the book, the inclusion of much data on obsolete equipment for historical reasons, and particularly, the descriptions of furnaces in the non-metallurgical industries represents a burden. A limited number of references are given as foot-notes and a bibliography of about 100 text-books including 3 foreign (American) is appended. The bookmaking is decidedly up to the usual Springer standard, with many space-saving illustrations. It is also up-to-date; latest developments such as electrical blast furnaces, drum furnace for production of pig iron from zinc-bearing pyrite cinders, the Paschke-Peetz process for acid smelting of low-Fe ores and various experimental furnaces for the direct production of steel from ore are discussed.

This volume can be recommended to teachers and embryo metallurgical engineers more than to full-fledged plant designers, although the last may in certain cases find it helpful.—ERICH FETZ.

Electrochemistry of Molten Salts

(Elektrochemie geschmolzener Salze)

Paul Drossbach

Verlag Julius Springer, Berlin, 1938. Paper, 6½ x 9½ in., 143 pages. 12 RM.

The author, a professor in the Technische Hochschule, Berlin, states in the preface that this is not intended as a text book nor as a discussion of technical processes, but instead to present the scientific foundation for the electrolysis of fused salts. Consequently 100 pages are devoted to theory, with more than half of them a mathematical discussion of thermodynamics and their application to the matters in hand, and the balance on electromotive forces, conductivity and density of fused salts, Faraday's law, energy consumption, methods of measurement of polarization voltage, and apparatus for electrolysis of fused salts.

The final 44 pages are devoted to a discussion of laboratory investigations on the fundamentals underlying the production of Li, Na, K, Rb, Cs, Be, Mg, Ca, Ba, Sr, Al, rare earth metals, Cu, Ag, Fe, W, Zn, Cd, Sn, Pb and Bi. No attention is paid to commercial production of any of these metals, nor to the patent literature which bulks so large in many German monographs. The author closes with a plea for scientific study of fused salts in general, without particular reference to whether the metal studied can be economically produced from the fused salt or whether the particular salt studied is the one that would be used from economic considerations. "Primitive methods" of trial and error should, he argues, be replaced by a scientific examination of every variable. The book is devoted to the attempt to clarify these variables and to develop fundamental principles.—H. W. GILLETT.

CURRENT news

Crucible Steel To Make Ledloy

The Crucible Steel Co. of America has received license to manufacture "Ledloy" under Inland patents. Ledloy is the new lead-bearing steel developed and introduced by the Inland company last year. A small amount of lead is added to the steel, so uniformly dispersed that it has no effect upon any physical properties, except to increase machinability. It is claimed that machining speeds in production runs of hot rolled and cold finished bars can be increased 30 to 100 per cent beyond the practical limits of ordinary steel, and tool life is extended 200 per cent or more.

The licensees to April 1 for making "Ledloy" include the following companies:

Bethlehem Steel Co.
Carnegie-Illinois Steel Corp.
Crucible Steel Co. of America
Guest, Keen & Nettlefolds, Ltd. (British)
Joslyn Mfg. & Supply Co.
Keystone Steel & Wire Co.
Northwestern Steel & Wire Co.
Pittsburgh Steel Co.
Youngstown Sheet & Tube Co.

Major Bull's Library at Battelle

The reference library at Battelle Memorial Institute has just been enlarged by 600 valuable bound volumes as the result of a gift from the family of the late Major Robert A. Bull.

Major Bull was a recognized technical leader in the foundry industry, twice president of the American Foundrymen's Association, and member of many other technical societies. During the years of his service to the steel castings industry, he gathered an extensive private technical library. It is this collection that has been entrusted to Battelle in order that it may remain in active use.

The Battelle library now comprises over 7,500 volumes pertaining to metallurgy, ceramics, chemistry, fuels, and related subjects. The Bull Collection, which is exceptionally complete in the American and English foundry field, greatly adds to its usefulness for metallurgical research.

● Clarence E. Sims, metallurgical supervisor, Battelle Memorial Institute, Columbus, Ohio, is visiting in England for the purpose of studying developments in the iron and steel industry.

Studies Planned by the Ferrous Metals Committee

Metal cutting and welding with city-gas-oxygen torches; recent advances in the use of prepared gaseous atmosphere furnaces; and new heat-treating processes which have been developed in the past year were the three subjects singled out for study and analysis during 1939 by the Ferrous Metals Committee, Industrial Gas Section of the American Gas Association, at a recent New York meeting. The new Chairman of this group, acting in behalf of improved applications of gas to the iron and steel industry's heating jobs, is Clayton S. Cronkright, Public Service Electric & Gas Company, of New Jersey.

Paramount in the committee's mind this year will be the economic considerations involved in the use of city gas in the three fields noted. Actual cost studies of numerous applications will be made. Several and frequent interim bulletins will be issued to disseminate useful data to the trade.

News from A. G. A. headquarters indicates that the most likely "first" in the committee's series of bulletins will concern cutting and welding with gas—not a new use for city gas, but one in which interest has revived noticeably of late, and one which has never been fully capitalized upon by the metal industry. New standards of economy are being established in the use of city-gas-oxygen torches, particularly for scarfing, scaling and deseaming. One of the largest steel companies has recently found that one cubic foot of natural gas can do the job of one cubic foot of much more expensive acetylene, and with only 5 per cent more oxygen. Other steel industry leaders are getting similar results in manufactured as well as natural gas territories.

Studies of prepared gaseous atmosphere units will cover all types of equipment for generating (from city gas) both protective atmospheres and process atmospheres. Apparatus by the American Gas Furnace Co., C. M. Kemp Mfg. Co., Surface Combustion Corp., Mahr Mfg. Co., General Electric Co., Westinghouse E. & M. Co., Sentry Co., Lithium Corp. of America; Electric Furnace Co., and J. P. Devine Mfg. Co., will be considered both functionally and economically.

New heat-treating processes to be reported upon include: Air furnace heating, cyaniding in gas atmospheres, and high speed steel units, such as the new Charmo, represented as record-setters in preventing decarburization.

Udylite Corp. Acquires Bright Nickel Corp.

All the capital stock of the Bright Nickel Corp., Detroit, owners of the basic Schlotter patents covering bright nickel plating process, has been acquired by the newly-formed Udylite Corp. Preceding the acquisition of the capital stock of the Bright Nickel Corp., the Udylite Co. formed a new organization to be known as The Udylite Corp. which has taken over all of the business and assets of the Udylite company. This company is widely known as one of the leading plating and polishing supply and equipment houses in the country.

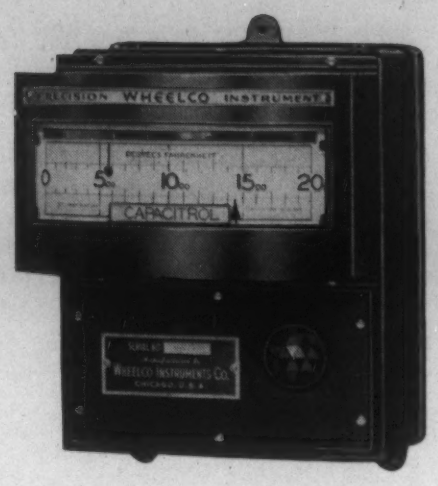
The advantage of the bright nickel process results from materials coming from the tanks bright and shining, thereby eliminating buffing, with a consequent saving in time, labor and money. The Bright Nickel Corp. will be operated as a wholly owned subsidiary of The Udylite Corp.

The personnel and policies of The Udylite Corp. will remain the same as those of The Udylite Co., which it supersedes and the same management will continue. Officers of the new corporation are as follows: Charles Awkermann, chairman of the board; L. K. Lindahl, president; C. H. Reeme, vice president; and Horace Maynard, secretary.

The new corporation, through the acquisition of the Bright Nickel Corp., can now offer the metal finishing industries a more complete range of products and processes, increased technical facilities as well as an organization equipped to handle a more rounded-out variety of metal finishing problems.

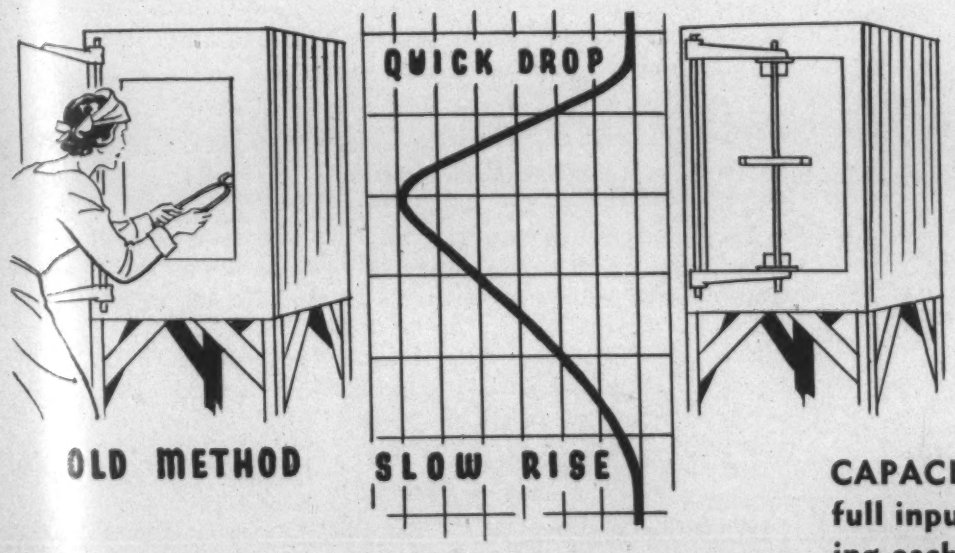
(Continued on page MA 246)

INCREASE OF 6 PRODUCTION HOURS PER DAY WITH CAPACITROL



Production equivalent to two additional working hours are gained each eight-hour shift, per furnace (a total of six hours in three shifts) in the production of tubes by one of the largest electrical manufacturers in the country, since CAPACITROL "No-Contact" temperature controllers were installed. With the old control system, each opening of furnace door for servicing production dropped temperature 150°.

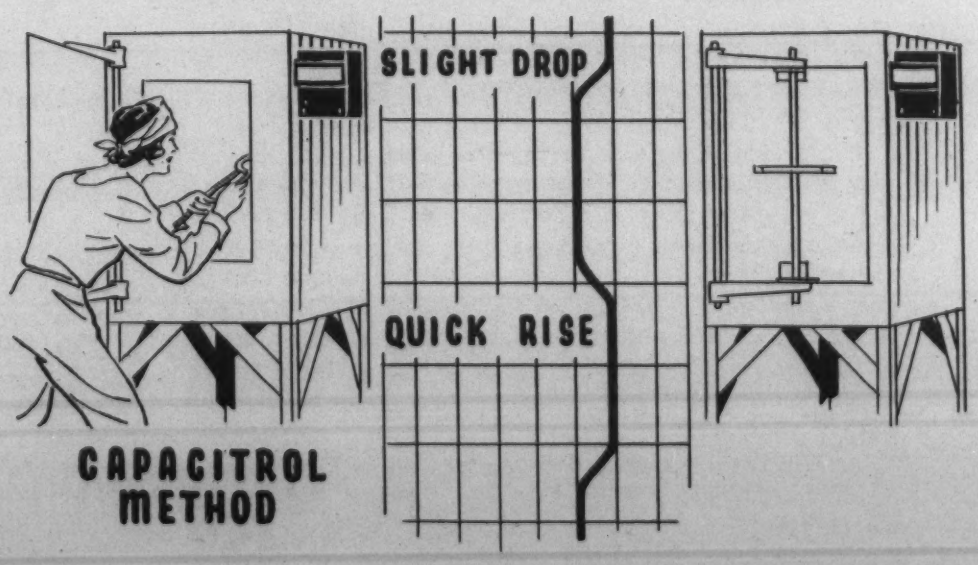
"No-Contact" Temperature Control



CAPACITROL controller permits increase of heat to full input, resulting in slight drop of temperature during each door opening and the time required to bring temperature back to operating level (400° F.) is considerably shortened, thereby advancing production 25%. Engineer states CAPACITROL will pay for itself in several months. No known method of temperature control can equal CAPACITROL "Hair-Line" control.

REPORT 1345 is the basis of these facts.

CAPACITROL literature on request.



WHEELCO INSTRUMENTS CO.
1929 SOUTH HALSTED STREET • CHICAGO

New Curricula at Brooklyn Polytechnic

New curricula leading to the degree of bachelor of metallurgical engineering and bachelor of aeronautical engineering, respectively, have been added to the program of the Polytechnic Institute of Brooklyn according to an announcement by President Harry S. Rogers.

Although many of the subjects embraced in the new curricula have been offered for years, either as required or elective prerequisites to the mechanical engineering degree, the growing demand for students specially trained in both metallurgy and aeronautics has been responsible for the inauguration of the new degree curricula. Although the matter has been under consideration for some time, the decision to offer the courses was not made until careful analyses had indicated that definite opportunities for students existed in both fields. Pres. Rogers said:

> We have a dual responsibility, both to industry and to our students, and I know of no technical school in the country where this responsibility is so definitely assumed as at the Polytechnic. The faculty members directing these new courses have been studying the practices and the scientific developments taking place in industry. A surprising number of new developments in industry are actually born right here in our laboratories and our students frequently become familiar with what later becomes accepted commercial practice while they are still undergraduates. It is with this sense of responsibility and thorough preparation of facilities that we now offer the new curricula.

The phenomenal growth of the metal industries has opened one of the most promising fields for metallurgical research in recent years. New alloys, new treating methods and new metal fabricating practices have developed a need for new workers, capably trained in physical metallurgical lines.

By virtue of its metropolitan location, and ease of access, the Polytechnic is in the center of an important metallurgic field. Twenty per cent of all the copper refining in the country is actually done in Brooklyn; 50 per cent within a 40-mile radius. All the large fabricators of copper and copper alloys, Westinghouse, General Electric and Western Electric, besides hundreds of smaller manufacturers of raw and finished metal products have plants within the Greater New York area.

The aeronautical engineering curriculum is one for which numerous requests have been made by students, engineers and manufacturers associated with the aircraft industry, according to Dr. Rogers.

Bessemer Gold Medal to James Henderson

The Council of the Iron and Steel Institute, London, England, has decided to award the Bessemer Gold Medal to James Henderson. The Bessemer Medal was founded by Sir Henry Bessemer and is awarded annually for distinguished merit in promoting the technical and metallurgical development of the iron and steel industry; it is the highest honor which the Institute can give.

James Henderson has had a remarkable career. For 45 yrs. he was associated with the technical development of the Frodingham Iron and Steel Co., Ltd., in North Lincolnshire and held all positions from chief metallurgist to managing director. During that period the Works became one of the most important in the country and were associated with such important developments as the introduction of the Talbot direct metal process, the use of blast-furnace gas in blowing and power engines, and the installation of modern plate mills.

Mr. Henderson is now deputy chairman of the renamed Appleby-Frodingham Steel Co., Ltd., and a director of the United Steel Companies, Ltd.; he is past-president of the British Iron and Steel Federation and of the Lincolnshire Iron and Steel Institute; a former chairman of the Lincolnshire Ironmasters' Association and of the Iron and Steel Industrial Research Council; a member of Council and honorary treasurer of the Iron and Steel Institute. He is one of the only two Englishmen whose services to the industry have been recognized by nomination to honorary membership of the Verein deutscher Eisenhüttenleute.

Army Establishes a Gage Laboratory

The Ordnance Department of the United States Army will establish a gage laboratory at the Carnegie Institute of Technology this spring, thus considerably increasing facilities for research and industry in the Pittsburgh district. The primary purpose of the laboratory is to make available standard measurements of the greatest accuracy for the machines which produce Army equipment. More than $20,000 worth of delicate precision instruments, accurate to the hundred-thousandth and millionth of an inch, will be installed in a laboratory in Industries Hall at Carnegie Tech.

The laboratory will be operated under the general supervision of Dr. Webster N. Jones, director of the College of Engineering at Tech, and Major C. H. Morgan, executive officer of the Pittsburgh Ordinance District. Professor C. C. Leeds of Carnegie will be in charge of the laboratory.

The equipment makes possible measurements within two-millionths of an inch by means of the Van Keuren light wave equipment used to determine the wear on Johanssen precision measuring blocks or diameters of ball bearings and similar measurements where great precision is essential. Another piece of equipment measures length to the hundred-thousandth of an inch. Other apparatus includes a screw thread testing machine, comparators, microscopes, micrometers, surface plates, straight edges, levels, parallels, and squares. All precision equipment has been calibrated at the U. S. Bureau of Standards, and the tabulated calibrations are part of the laboratory records.

This laboratory is a valuable asset to Carnegie Tech, making available a place where instruments may be calibrated prior to research investigations. Industries in the district will also use the equipment.

The Ordnance Department will use the laboratory to train ordnance reserve officers as Army inspectors of ordnance, and employ its facilities to calibrate and inspect gages on current manufacturing orders. The laboratory will be of tremendous value for national defense in the event of emergency by facilitating check of inspection gages and accelerating of inspection work. The laboratory will be formally dedicated the latter part of April.

J. J. Crowe Honored

John J. Crowe, research engineer for Air Reduction Sales Co., New York, has been awarded the 1937 James Turner Morehead Medal, sponsored by the International Acetylene Association. The medal, which is awarded annually for outstanding work in the production or utilization of calcium carbide and acetylene, was presented to Mr. Crowe during the opening session of the 39th convention of the International Acetylene Association in Houston, Texas, early in March. The inscription on this year's Morehead medal, "For his unceasing and successful technical activities", is indeed a fitting tribute to the recipient.

Zinc Institute's Annual Meeting

The 21st annual meeting of the American Zinc Institute will be held at the Hotel Statler, St. Louis, Mo., on Monday and Tuesday, April 17 and 18. On Monday the Institute will report on its activities during the past year. The Institute's promotion work will be specially featured. On Tuesday several speakers will be heard on the subject of the market for zinc coated products. The program will also include a number of technical topics of vital interest. The Steel Corporation's technicolor movie "Men Make Steel" will close the afternoon session. Entertainment features will include the annual dinner which will be held on Monday evening.

● R. S. Van Note, since 1929 New England representative, has been appointed assistant manager of sales by the C. M. Kemp Mfg. Co., Baltimore, Md.

(Continued on page MA 249)

Steel Purchasers Beware!

According to a recent warning issued by the Purchasing Agents Association of New York to its membership, steel buyers should be extremely cautious in dealing with strange steel salesmen representing foreign concerns. Within one week 4 association members reported that officials of their companies had been approached by a man purporting to represent a certain European steel maker (the association has the name) and in 2 instances an order was given for "samples" of tool steel. Inasmuch as the swindler in question may approach some of our readers not members of the Association, we are glad to publish part of the warning, with the permission of the association:

The technique is the same as has been employed periodically during the past 10 yrs: A suave salesman with the best of Continental manners, through certain credentials and impressive letters of introduction, gets an interview with the president, or some other executive of the company; but never with the purchasing agent.

His sales talk is somewhat technical and not too definite as to details. He states prices in francs, which the buyer might assume to be French francs but is later invoiced in Swiss francs. He creates the impression that dimensions are in feet, when in fact, meters are specified.

Here's the crux of the swindle: The order usually is incorporated in a letter rather than a purchase order and always ambiguous in terms—the terms being suggested by the salesman. The purchaser believes he is ordering a "sample", but when the shipment arrives, his "sample" consists of several hundred pounds of bars of various lengths and sizes and billed at from $750 to $1200. In an earlier epidemic of this swindle, one large company was billed for $4,000 for the stuff. The price quoted is about 95c a lb. and the steel is found to be the equal or inferior to our domestic product.

We suggest the following precautions for protection against this fraud:

Use only your own order blanks; prepare your own wording.
Be sure the maximum quantity is clearly stated in the order in dimensions you understand.
Be sure you specify in your order the maximum amount of the order *in dollars.*
Advise all officers, superintendents and foremen to be on their guard.

This advice may appear elementary—but some of the large concerns of the country have been misled because elementary precaution was not taken.

American Council of Commercial Laboratories

Leading research and testing laboratories of the country have mutually bound themselves together in the American Council of Commercial Laboratories to maintain testing, research, inspection and the laboratory art as a whole upon a high plane and to conduct their operations in such a manner as to insure competency and reliability in whatever they may undertake. Member laboratories are located from coast to coast with branch laboratories and inspection stations in every important city and industrial center in the country. Membership in the Council is open to commercial laboratories which qualify to the strict requirements and pledge to abide by the high code of ethics set up in the Council By-Laws.

Formation of the Council has taken on important aspects in recent months not only in the line of research, testing and inspection of new product developments but with the scientific equipment and trained personnel of experts of the combined laboratory group the commercial testing laboratories have set up through the Council a means of assisting in the mobilization of industry in time of emergency.

The Council has prepared a brochure listing its aims and showing the scope of the work and equipment of member laboratories. Copies of the brochure may be obtained by writing D. E. Douty, secretary, 1415 Park Ave., Hoboken, N. J.

● The ninth semi-annual Eastern Photoelasticity Conference will be held at Cornell University, Ithaca, N. Y., on Saturday, May 13. The Committee on local arrangements, of which Prof. F. G. Switzer of the College of Engineering at Cornell is chairman, expects an attendance of approximately 100 scientific workers in this field, both from college faculties and from the research staffs of various industries. The program of technical papers will be supplemented by an exhibit of the latest equipment for photoelastic research, and demonstrations in the Cornell laboratories.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Professor of Metallurgy desires position for three months starting June first. The possibility of developing into permanent position of added interest. Ph. D. in physical chemistry and physical metallurgy. Four years of industrial experience and eight years of teaching experience in engineering schools. Will consider either teaching or industrial position. Box MA-127.

HELP WANTED: Representative with ability to sell bronze and brass ingots in Northern New York State and Pennsylvania, knowledge of foundry practice desirable. Box MA-131.

HELP WANTED: Young metallurgical or foundry engineer, with some practical molding experience, for sales of alloys and development of markets for alloy iron and steel castings in central western territory. Box MA-132.

POSITION WANTED: Metallurgist desires technical sales position. Employed, and for the past eight years, by nationally prominent manufacturer. Experienced in all phases of heat treating, physical testing, processing, fabrication, application and production of plain carbon, alloy and tool steels. Box MA-133.

HELP WANTED: Man for sales or outside service work on pyrometers; experience not necessary if capable of learning, and willing to start at moderate salary. Box MA-134.

HELP WANTED: Experienced pyrometer men for New York and Philadelphia, capable of producing and supervising district sales and services. Unlimited opportunity with growing organization. Proper remuneration. Box MA-135.

POSITION WANTED: X-Ray operator thoroughly experienced desires suitable connection. Box MA-136.

● Dr. John F. Thompson, chairman of the Whitehead Metal Products Co., Inc., has announced that Thomas M. Bohen, vice-president of the company, had been elected president to succeed the late J. J. Whitehead. At the same time Herbert G. Fales, a vice-president of The International Nickel Co., Inc., was elected vice-president and Clayton D. Grover was made assistant to the president. The Whitehead company is a wholly owned subsidiary of International Nickel.

● H. P. Dolisie, of Montreal, Canada, and Henry Booth, of New York, have been elected president and vice-president respectively of International Acetylene Association for 1939. H. F. Reinhard, also of New York, was re-elected secretary. The election was held during the Association's 39th convention held early in March at Houston, Texas.

● In order to expand their services to industry so as to include not only metal cleaning but also certain production phases of finishing, the Detroit Rex Products Co., 13005 Hillview Ave., Detroit, Mich., has expanded its sheet metal manufacturing division. I. J. Belanger, formerly of the Belanger Fan & Oven Co., Detroit, has been appointed manager of this division.

trends

BY EDWIN F. CONE, EDITOR

Carbon Linings for Blast Furnaces

Our first article in this issue deals with a subject of prime interest to operators of American blast furnaces—carbon linings for certain portions of pig iron furnaces. The trend in Germany, according to an American engineer who recently visited that country, is decidedly in this direction. He reports some striking applications of carbon block linings with highly satisfactory results. This article, written by an authority on refractories and ceramics who has spent much time in Germany, England and the United States, discusses some of the results of such linings in Germany, Russia and Sweden. None are yet used in the United States.

Spectrographic Control

The installation late last year of a complete spectrographic laboratory by the Ford Motor Co., at its Dearborn plant is a significant development in a comparatively new field—control of the composition of heats of alloy iron. It is being used to largely displace the use of chemical analysis. It is stated that it requires only 8 min. to analyze with the new equipment 6 different samples for 6 elements—a total of 36 determinations made in a fraction of the time needed for chemical analysis. The advantage, both as to time and to accuracy, is obvious in a foundry where several hundred tons of metal is poured a day.

Vacuum Melting

Every now and then we hear something about vacuum melting. Outside of Rohn's plant in Germany, vacuum melting is still in the research laboratory stage, so far as we can learn. Ordinarily instead of using a vacuum, one will use a neutral or a helpful atmosphere, for it is generally the atmosphere rather than the pressure that counts. There is evidence to the effect that the atmosphere is being considered as a possible factor in all melting operations.

Insulating Firebrick

According to an authority the use of insulating firebrick is on the increase. Economies have been achieved by several steel companies by using this type of brick in covers for soaking pits—a lighter cover, requiring less power and lighter motors, as well as longer service life. Fuel savings are also cited.

Light Metals Replacing Steel in Germany

According to a news item from London, published in *The Iron Age,* Gen. Von Hanneken of Germany is quoted as saying that wherever possible, non-ferrous metals, especially magnesium and its alloys, are being substituted for steel and iron. Industries have been ordered to supersede iron with light metals and as a result the automobile trade is using magnesium alloys to an increasing extent. Armament plants have first call on iron and steel supplies. It is stated that Germany has unlimited supplies of magnesium. This trend will bear watching since German metallurgists have always been skilled in such developments.

Low-Alloy Steel Castings

Analogous to the development of the low-alloy, high strength steels for structural purposes is the production of low alloy steel castings for side frames, bolsters and so on for freight and passenger cars. This is in line with the trend to lighten the weight so as to increase the pay load. Conspicuous among such steels are the nickel-manganese and the manganese-vanadium cast steels as well as the later development of a titanium-manganese alloy steel. Research work in this field is progressing rapidly.

Pearlitic Malleable Iron

The development and exploitation of pearlitic malleable irons is pointed to as one of the greatest single contributions of the malleable iron industry this past year. New uses for this material are being sought and predicted. The versatility of pearlitic malleable as a material, as pointed out by H. A. Schwartz in *Steel,* is demonstrated by the rather wide variety of properties desired for various purposes and the correspondingly wide range in service conditions to which this material, produced by different vendors, is suited. As the years go by, he says, there will perhaps be "some possibility of the standardization of properties desired and methods of manufacture leading to a reduction in the number of such materials on the market." This situation may be clarified by new specifications by the A.S.T.M.

Better Steel Castings

A tendency in the right direction is the meeting each month of operating executives of the American steel casting industry who exchange technical information "with the dual purpose of improving the quality of production and increasing production efficiency." This has been developed by the Steel Founders' Society of America.

Inspecting with the Spectrograph

We understand that the spectrograph is being used by a large department of the U. S. Government in a rather unusual manner—inspection of material on a large scale. Among some of the advantages claimed are a larger saving in time and pronounced accuracy.

More Uses for Steel Castings

New applications for steel castings are reported on the increase. Engineers of the Ford Motor Co. have announced that the utilization of steel castings has been extended in that organization so that now 149 lbs. of such castings are used in every car.

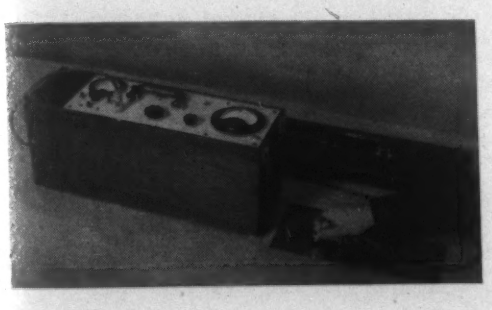
New Equipment and Materials

Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts no more than 2 in. wide.

The Profilometer Measures Surface Roughness

The roughness of a surface consists of the finely-spaced irregularities which usually determine the "finish" of the piece. These irregularities are seldom more than a few thousandths of an inch wide, and much less in depth. Several hundred such wiggles are covered in traversing an inch of the surface. Roughness measurement consists of determining the magnitude of these irregularities.

The "Type P Profilometer" developed by the



Physicists Research Co., Ann Arbor, Mich., measures a running average of the height of the irregularities which constitute the roughness of the specimen. The tracer shown in the illustration carries a small diamond point which is held against the surface by light spring tension. It is sharp enough to bottom the irregularities, but does not scratch or otherwise damage specimens of ordinary hardness, such as steel, cast iron, glass, bronze, etc.

The motions of the tracer point are transformed to electrical voltages in the tracer, and amplified and measured by the instrument. The automatic averaging feature is provided by the electrical meter, which is calibrated directly in inches. The meter takes an rms (root mean square) average, which is the average commonly used for oscillating quantities. For a simple curve, the rms value is 35% of the peak to valley height.

The Type P Profilometer is designed for shop use. It requires no external connections, and can be carried to any job and measurements made in place. The tracer is about the size of a pack of cigarettes, and measurements can be taken on almost any surface on which this tracer can be placed. In many cases, readings have been made with the part still on the producing machine, and frequently with the machine in operation.

Mechanically, the measurement requires no more skill than using a micrometer. The tracer is moved across the surface whose roughness is to be determined, and the meter reads a continuous running average of the height of the surface irregularities. For convenience, the scale is calibrated in microinches. One microinch is .000001 in. The tracer can be moved manually or mechanically as desired. For very smooth surfaces (less than 3 micro-inches), mechanical trace is recommended. It is not necessary to press the tracer hard against the surface, as its own weight is sufficient. The reading obtained is independent of the pressure between the tracer and the specimen. The readings obtained are independent of the speed of trace over wide limits. A speed of trace of about 1 in. per second is suitable.

The reading of the instrument is determined by the roughness, and is not affected by the curvature of the piece. It can be used on flat, cylindrical, or curved surfaces of wide variety and shape. Adjustment for surfaces of different curvature is made by means of the small knob on the top of the tracer. This knob simply raises or lowers the tracer point to insure proper contact with the surface, and does not affect the reading.

A Redesigned Magnetic Separator

The Stearns Magnetic Mfg. Co., Milwaukee, Wis., which produces an extensive line of magnetic separators and magnetic friction devices, has completely redesigned its "Type DH" drum type magnetic separator. Separators of this type can now be applied to both wet and dry operations. The vibrating feeder now provided for dry operation affords a uniform flow of material and accurate control of the material to conform to the type of separation desired.

The Type DH is designed particularly for the purpose of removing impurities from finely ground materials. The vibrating feeder delivers free-flowing material in a uniform layer into the magnetic field where the impurities are eliminated. The even distribution of the material allows close and intensive contact with every particle as it passes through the magnetic field.

In the wet operation arrangements are made for an under feed of the slurry, contact of the flowing material being made in a dense, highly concentrated magnetic field. Impurities thus extracted are disposed of as the cylinder rotates, conveying them out of and beyond the flow where they are immediately discharged.

The Type DH magnetic separator is so designed that it can be built with a multiple drum arrangement, thus providing for the extraction of the most feebly magnetic particles by subsequent passing through various magnetic zones. The drums are built in various sizes, depending on the capacity desired.

Machine for Sheet Metal Fabricators

The new "Quickwork Combination Throatless Shear and Flanger" is a compact, versatile, low cost unit that will handle a wide range of sheet metal fabrication. It is of simplified unit type design for greatest utility—as a shear, as a flanger, or as both—as bench type or pedestal mounted machine—for production shop work or as portable equipment out on the job.

As a shear, it handles all straight and irregular cutting, including full circles and curves, both concave and convex. Material of any width or length can be cut. The smooth, even action of the self-feeding rotary cutters makes it easy to follow the most intricate layouts.

A simple, quick change of heads converts the

machine into a flanger which is equally simple and easy to operate. The shoulders of the flanging rolls act as a guide for the depth of flange. Attachments and rolls can also be furnished for U-ing, wiring, special flanging and forming.

This new machine is furnished arranged for two cutting and flanging speeds. It is ball bearing equipped throughout. Cutter and roll shafts have lifetime ball bearings and all drive mechanism runs in a bath of oil; thus reducing the lubrication job to a minimum. Complete information on this machine can be secured by writing the Quickwork Co., 400 W. Madison St., Chicago.

Bulk Fused Silica for Molding Sand Mixtures

Interesting possibilities in the way of improved molding sand mixtures are claimed through the use of fused (vitreous) silica as a new form of silica now available in bulk on a tonnage basis. The outstanding characteristic claimed for this form of silica is its extremely low expansion, producing mixtures of greatly increased resistance to thermal shock.

Combined with gelatinous silica as a binder having practically the same low expansion, molds of maximum indifference to thermal shock can be produced.

Samples of Vitreosil (vitreous silica) for this purpose, and any possible technical assistance will be gladly supplied by the manufacturers, The Thermal Syndicate, Ltd., 12 East 46th St., New York.

Solvent for "Piston Varnish"

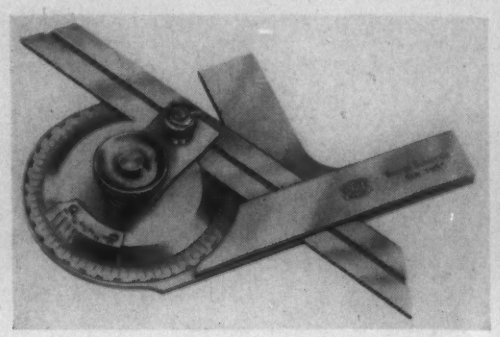
The chemical department of The Curran Corporation, Malden, Mass., announces the discovery of a novel aromatic solvent compound which is said to quickly dissolve "piston varnish". The new solvents are vaporizable at combustion chamber temperatures and the saturated vapors, upon cooling and reaching their dew point, precipitate copious quantities of the hot tar solvent. The dissolved piston varnish and/or carbonaceous tars may be conveniently removed from the engine by draining the old motor oil. The normal dose of 32 oz. should be administered just before oil change time, then any residual film or deposits will be completely removed from the engine with the draining of the motor oil.

For the time being this new solvent will be sold as "Gunk Piston Varnish Solvent."

Mauser Universal Bevel Protractor

The George Scherr Co. announces a "New Universal Bevel Protractor" of Mauser manufacture, producers of the well-known Mauser vernier calipers and height gages. This precision tool has been designed to meet the requirements of toolmakers, engineers, layout men and mechanics. It may be used for all types of work where angles must be laid out or measured. The dial is graduated in degrees for the full circle in 4 x 90 = 360 deg. A vernier is provided which gives readings within 5 min. of the arc (1/12th of a degree).

The graduations on both the main dial and



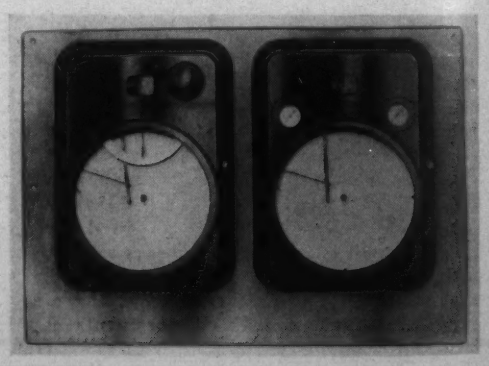
on the vernier are very finely etched with jet black markings, making readings quick and simple. The tool may be obtained with either 6, 8 or 12 in. blades, which are bevelled at each end to 45 and 60 deg., respectively. The back of the tool is finished flat so that it may be flush when laid on work or paper. The dial may be clamped rigidly by a thumb nut, while the blade may be clamped independently of the dial.

Layout men find the Bevel Protractor essential in laying out angles while toolmakers use it constantly to check their work. The new Mauser Universal Bevel Protractor has been placed on the market as an item for the individual mechanics' tool kit. The George Scherr Co., 128 Lafayette St., New York, N. Y., is the exclusive agent for the United States for Mauser precision tools.

Flow Ratio Control

The rate of flow of one fluid in definite ratio to the flow of a second fluid—automatically controlled—is accomplished by means of a new "Flow Ratio Controller", recently developed by The Bristol Co., Waterbury, Conn. One of the features of these controllers is an arrangement which permits changing the ratio at any time by simply turning a knob on the outside of the case.

Thus, a 5:1 ratio between the flow of air and fuel gas, a 4:1 ratio between the flow of natural gas and artificial gas, a definite ratio between two different kinds of gases in a furnace, or a definite ratio between the



lean oil and wet gas entering an absorber—these are some of the useful applications for these new instruments.

Bristol's Flow Ratio Controller consists of two instruments—one a standard flow recorder and the other a standard flow recorder controller. The rate of flow is measured and recorded by one instrument, which also sets the control point on the second. The latter then records and controls the flow proportionately to the first, depending upon the ratio selected. Bristol's revised Catalog No. 1051 describes these new instruments.

Special High Grade ZINC

Guaranteed 99.99+% Pure

WHEN you choose Anaconda Electric for the base of Zinc die castings, you are certain of obtaining uniform, dependable metal. For every slab of Anaconda Electric Zinc is electrolytically refined and guaranteed 99.99+% pure.

Anaconda Electric Zinc is supplied in 50 lb. slabs clearly marked "Anaconda Electric 99.99+%." Whenever you use this well-known brand, whether in small quantities or carload lots, you may be sure that *every slab will test 99.99+% pure.*

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ANACONDA from mine to consumer

ANACONDA SALES COMPANY

25 Broadway, New York

Subsidiary of Anaconda Copper Mining Company

Hoist Plugs Into Lamp Socket

Combining the dependability of big scale hoisting equipment with compact, light-weight convenience—this is what CM engineering has achieved in the new "Comet Hoist." Easily carried and installed by one man, the Comet is powered by a specially built heavy duty, high torque motor that runs on an ordinary light circuit or 3-phase power line. Just plug in, and the hoist is ready to go. No special installation or accessories needed. Use it anywhere. The compact design and ease of operation make the Comet especially valuable for service on production lines in large plants.

Yet, the price is low enough to make it ideal equipment for the smallest shop.

The construction of the Comet is compact and rugged, yet exceptionally light in weight. Precision ball bearings are provided at each rotating point. Gears are precision machined of heat-treated alloy steel. Controller, with patented "delayed reversing" feature, operates easily with one hand and affords an extremely sensitive control for lifting the load distances of a fraction of an inch. The brake is pointed to as smooth, quick acting, positive—prevents drifting of load—is easily adjusted. Upper and lower safety stops automatically limit travel of load hook.

The Comet is offered in four capacities 250, 500, 750 and 1000 lbs., and several speeds. The 500-lb. size weighs only 85 lbs. Construction and operating details are fully illustrated in literature available by writing the Chisholm-Moore Hoist Corp., 346 Fremont Ave., Tonawanda, N. Y.

New Paving and Slag Breaker

A new "Cushioned-Air" paving breaker, known as the "CC-80," has been announced by Ingersoll-Rand. It is an 80-lb. machine, and incorporates the most recent developments of the I-R line of paving breakers, pile drivers, slag remover, etc.

The air-cushioned piston on this breaker results in an easier holding hammer, especially at higher air pressures. Because there is less shock on the wearing parts and because the piston cannot strike the front-head, there is claimed less breakage and less upkeep. Other design features include a larger anvil-block bearing which insures correct alignment; an extra large built-in lubricator; reverse buttress self-locking threads on the fronthead bolts and the latch bolt of the steel retainer; and numerous additional refinements. Complete information is contained in form 2530, copies of which are available from the Ingersoll-Rand Co., 11 Broadway, New York City.

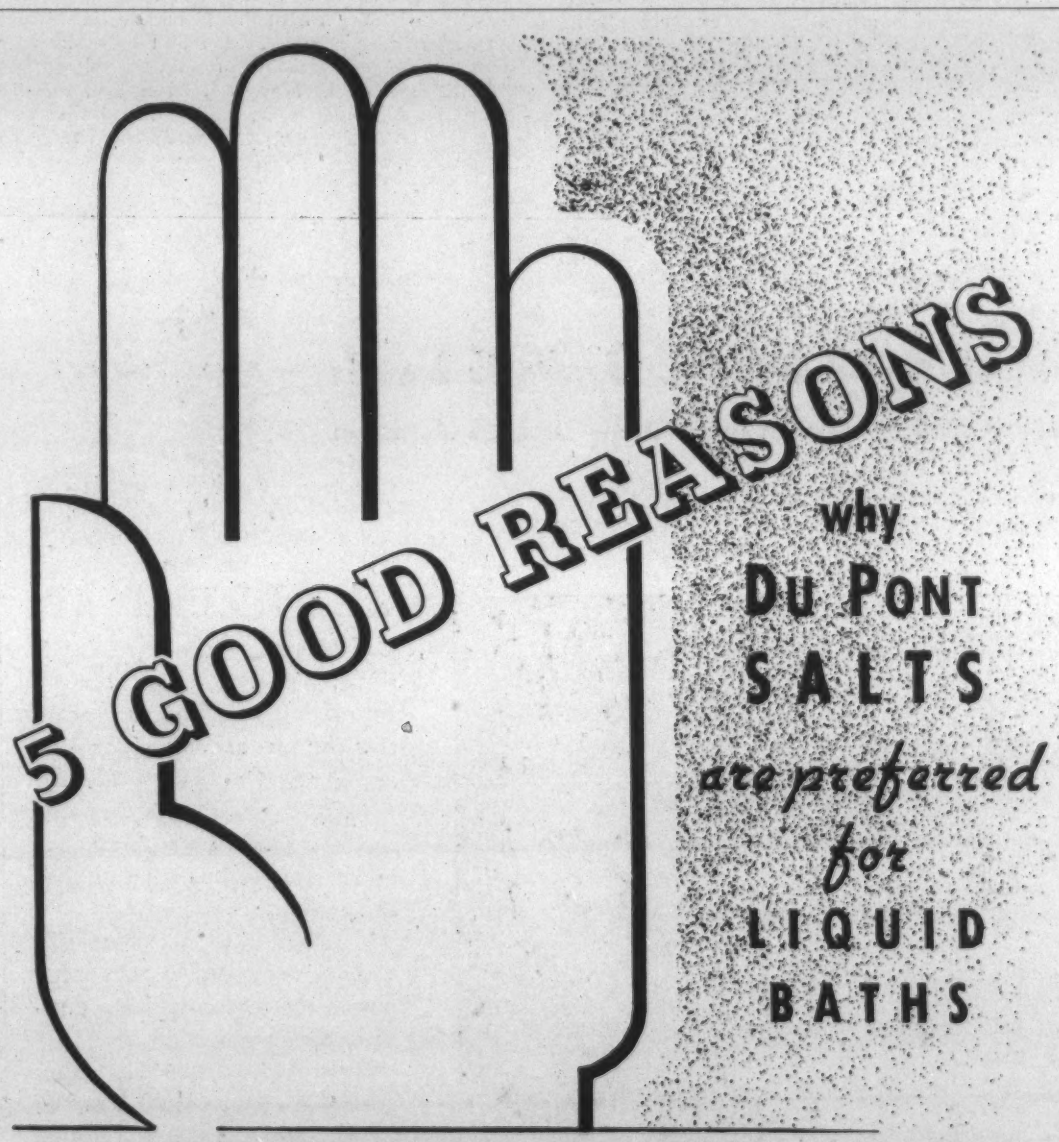
Bronze Welding Rods

Compressed Industrial Gases, Inc., Chicago, has announced two new bronze welding rods. These rods are known as "CIG No. 400 Ready-Fluxed Bronze Rods" and "CIG No. 401 Ready-Fluxed Manganese Bronze Rods." As their name implies, they are completely flux-coated throughout their entire length all ready for the oxy-acetylene welder to apply in his welding jobs.

This improvement in bronze welding rods is claimed more than simply an innovation. It is the most important step that has been made in bronze welding rod manufacture because it controls the even introduction of the chemically correct flux throughout the entire brazing operation. It prevents the weld from getting too much or too little bronze and completely shields the molten metal from the time the weld area is first tinned until the job is completed.

The CIG Ready-Fluxed Bronze Rods are designed for application in any type of bronze welding of all metals on which bronze is normally used without the use of additional flux. The CIG No. 401 Ready-Fluxed Manganese Bronze Rods are particularly desirable for bronze welding of cast iron. In bronze welding applications where powdered flux is used, it requires approximately 1 lb. of flux for each 25 lbs. of bronze deposited, or about 4 lbs. of flux to each 100 lbs. of bronze. Since this amount of flux costs the user approximately $5 it can readily be seen that considerable savings will be attained in the actual cost of the product itself. In addition, there are substantial savings to be effected in time and labor and oxygen and acetylene gases.

CIG "Ready-Fluxed" Bronze Rods are made in the Chicago plant of the Hollup Corp., a subsidiary of Compressed Industrial Gases, Inc. Conveniently located stocks are maintained at the District Offices of the companies in principal cities in the United States.



WIDE OPERATING RANGE: Consistently good results can be obtained within wide variations of temperature and operating conditions.

UNIFORMITY: All du Pont salts are uniform mixtures with a guaranteed cyanide content.

STABILITY: Du Pont salt baths have a low rate of decomposition. Bath activity is easily maintained with moderate replenishment.

ECONOMY: A result of unusual stability and efficiency in operation; low rate of replenishment and small dragout losses.

SERVICE: Our trained metallurgists are at your call to cooperate with you in the solution of any liquid bath problems. Just call or write our nearest office.

Plan to visit the du Pont exhibits at the *Golden Gate International Exposition* in San Francisco and at the *New York World's Fair.*

DU PONT

E. I. DU PONT DE NEMOURS & COMPANY, INC.
The R. & H. Chemicals Department
Wilmington, Delaware

District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

"Automatic Emulsifying" Safety Grease Solvent

The research laboratory of The Curran Chemical Corp., of Malden, Mass., has developed a new hydro-degreasing safety solvent to be used for degreasing and deoiling metal airplane fuselage and engine nacelles of aluminum skin construction. In addition to possessing excellent wetting out and solvent action upon heavy grease and carbon exhaust smut, this new solvent is said to have "automatic emulsifying" properties when it is associated with a substantial amount of water.

Practical tests made in the field show that large military or transport planes may be deoiled and degreased by simply spraying the under fuselage and the engine nacelles with the solvent composition at apparently a very low cost. Then the solvent is sluiced and washed away with a water hose which automatically emulsifies the grease and oil. The oils and dirt are removed in a milky "oil-in-water" type of emulsion which entirely eliminates fire hazards and clogging of the sewer drains. It is stated that the solvent is safe for use on aluminum or magnesium alloys under all possible conditions and concentrations. This new solvent will be sold as "Gunk Concentrate P-92—Aviation Grade."

Durable Transparent Metal Coating

A new transparent protective metal coating which is said to withstand the action of sunlight, moisture and climatic changes is announced by The Fales Chemical Co., 545 Fifth Ave., New York City. It is claimed that this coating—"Seal-Cote"—has been used successfully with copper, brass, bronze, steel and other metals and has preserved their original finish even when exposed to the weather for at least six months.

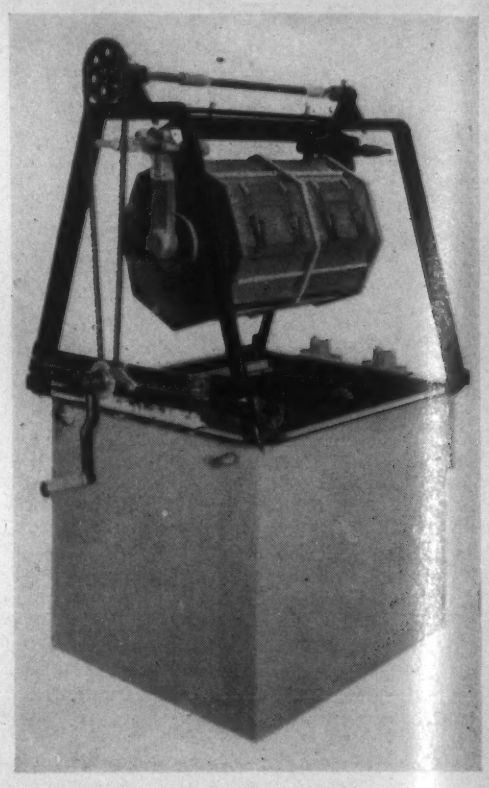
It has already been adopted by two exhibitors at the New York World's Fair. It may be sprayed or brushed on by a simple technique.

Brass and Bronze Ingots

The Metal Reduction Corp., North Bergen, N. J., announces that it is now in production of brass and bronze ingots under the brand name of "MeRitingots". Complete laboratory facilities have been provided and both standard and special composition of guaranteed quality will be furnished. Martin J. Bernstein, formerly of R. Lavin & Sons, Chicago, and the Vulcan-Louisville Smelting Co., is in full charge of production.

Hand-Operated Plating Barrel Hoist

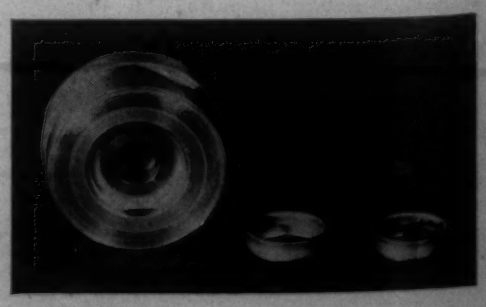
An improvement in plating barrel construction has recently been perfected in the form of the Mercil hand operated hoist for single cylinder plating barrels, made by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electro-plating equipment and supplies. This type of hoist which is very simple and inexpensive, consists of an iron framework, on top of which are two brackets with bronze bushings carrying a 1¼-in. shaft. A ¼-in. wire cable is wound around this shaft, at one end of which is a ⅝-in. pitch, 36-tooth sprocket connected to a 12-tooth sprocket at the lower end, with a ⅝-in. pitch roller chain. The 12-tooth sprocket is mounted in a 1¼-in. shaft which carries the ratchet and crank handle and also runs in a bronze bearing. It is possible to reverse the position of the crank handle to the opposite side of the tank as the parts involved are removable and arranged for assembly on either side of the framework. There is a 3 to 1 ratio which requires about 15 turns to lift a 14-in. diameter barrel and about 17 turns for lifting a 20-in. barrel.



Carbide Inserts for Dies

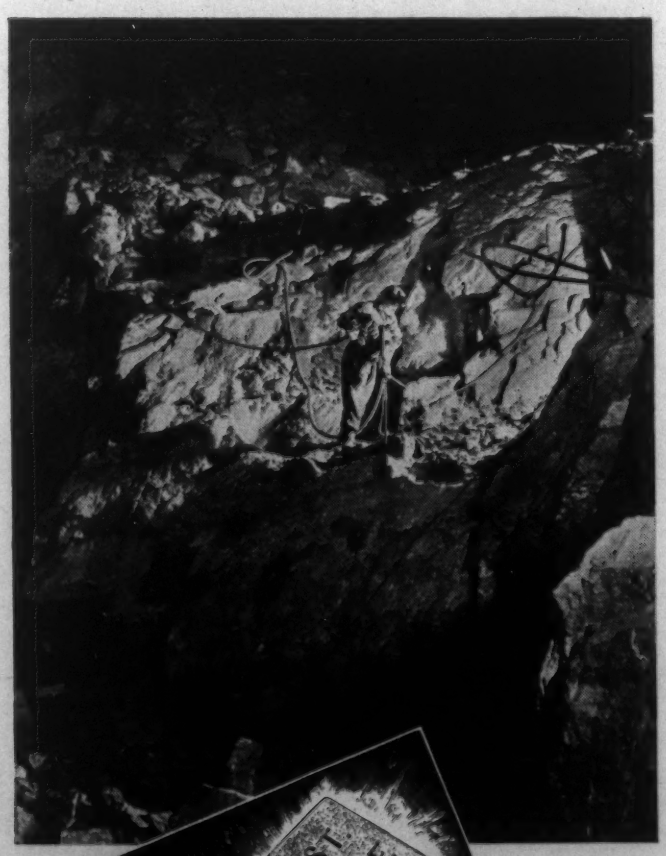
A new hard carbide insert for dies used in stamping and drawing automobile parts, chair casters, bottle caps, cans, electrical appliances, wire and other metal products for home and industrial use, has been announced by McKenna Metals Co., 158 Lloyd Ave., Latrobe, Pa. Recent tests conducted by a large caster manufacturer are said to indicate that dies faced with the new material, known as Kennametal, will outlast ordinary tool steel dies many times.

In regular production runs Kennametal-faced dies stamped out 70,000 chair centers before the first regrind, as compared with a total life of 14,000 pieces for the best tool steel die they had been using. While this represents an increase of 500 per cent in the number of pieces turned out, Kennametal-faced dies actually have an even greater advantage, for they may be reground several times before being discarded. The die in the illustration has stamped out 11,000 casters without any visible sign of wear. The basic ingredient of Kennametal alloys is an intermetallic compound of tungsten-titanium carbide, corresponding to the formula $WTiC_2$.



FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 3 of a Series



THE DRILLMAN

One of the key men in mining is the drill runner, with a keen eye for pay ore, a strong arm for controlling his throbbing machine, and an experienced knowledge for the proper placing of holes to ensure the maximum rock tonnage broken for the minimum of time and dynamite consumed.

Two hoses connect with his drill, one for the compressed air for power, the other supplying dust-preventing water.

He works 500 to 2,000 feet underground in a temperature of 60° F. On the surface it may be a stifling summer day, or 35° below zero, as it was one morning in January 1939.

He drills, loads his holes and fires (blasts) them, in the Edwards and Balmat zinc mines of the St. Joseph Lead Company in northern New York State. From here the concentrates are shipped to the Company's smelter at Josephtown, Pa., for conversion into the new electrothermic Highgrade, Intermediate and Prime Western grades of St. Joe Zinc.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE • NEW YORK
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PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Small Heat-Treating Furnace

A furnace known as "Type MI-3" and offered by the Cooley Electric Mfg Corp., Indianapolis, Ind., is designed for application to a little more severe service than is expected of laboratory muffle furnaces. It is well suited for heat treating small parts and can be operated at 1750°F. continuously and 1850°F. intermittently.

The furnace is unusually heavily insulated, and incorporates a cast iron door and a cast nickel-chromium hearth plate. Chamber size is 7⅜x5¼-in. It is extremely rugged and durable. It is supplied with 3400 watts at 220 volts, single phase,, a.c. or d.c. and can be furnished either with or without the pyrometer.

When it is desirable from the type of operation, this furnace can be equipped with a heating unit in the door to furnish additional heat at this point. Working dimensions of the chamber are 6¾ in. wide by 5 in. high by 14 in. deep.

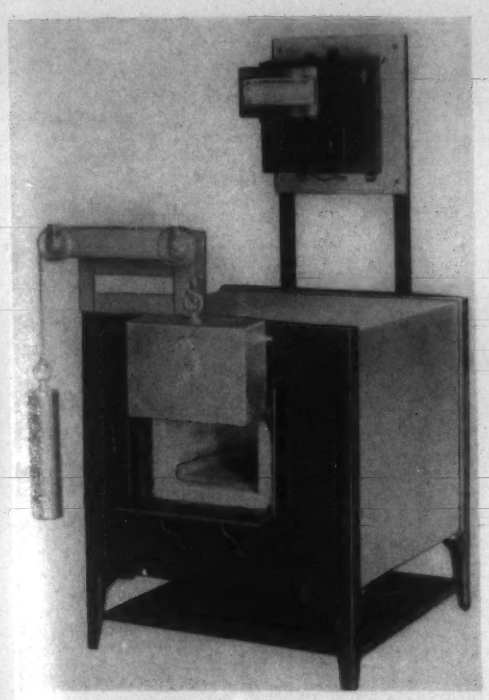
Moly Briquettes

Molybdic oxide briquettes are composed of a mixture of technical molybdenum trioxide and a sulphur-free pitch binder, briquetted under hydraulic pressure. The proportions of the molybdenum trioxide and the carbon in the binder are such that the briquettes are completely self-reducing.

The Climax Molybdenum Co., 500 Fifth Ave., New York, has developed and patented these briquettes both in this country and abroad with the idea originally of providing an economical and convenient means of making molybdenum additions to cast iron, either in the cupola, or in electric or air furnaces. However, it was soon discovered that they also have practical advantages as a means of adding molybdenum to steel.

The briquettes are cylindrical, being about 3½ in. in diameter by 4½ in. long, and weighing about 5 lbs. Although the molybdenum content of the material may vary, adjustments in size and weight are made so that every briquette contains exactly 2½ lbs. of metallic molybdenum. They are packed in cartons, four to the carton, thus each carton contains 10 lbs. of metallic molybdenum.

These briquettes are being used under ordinary working conditions to produce iron containing molybdenum in desired percentages up to 2 per cent. They are also being used to produce molybdenum steels of various types. In both cases recoveries are in the order of 95 to 100 per cent. There is no carbon pick-up in either case. Concerning the composition of the new briquettes and the methods of using them, these factors are covered in considerable detail in a pamphlet which is available to anyone interested in obtaining complete information.

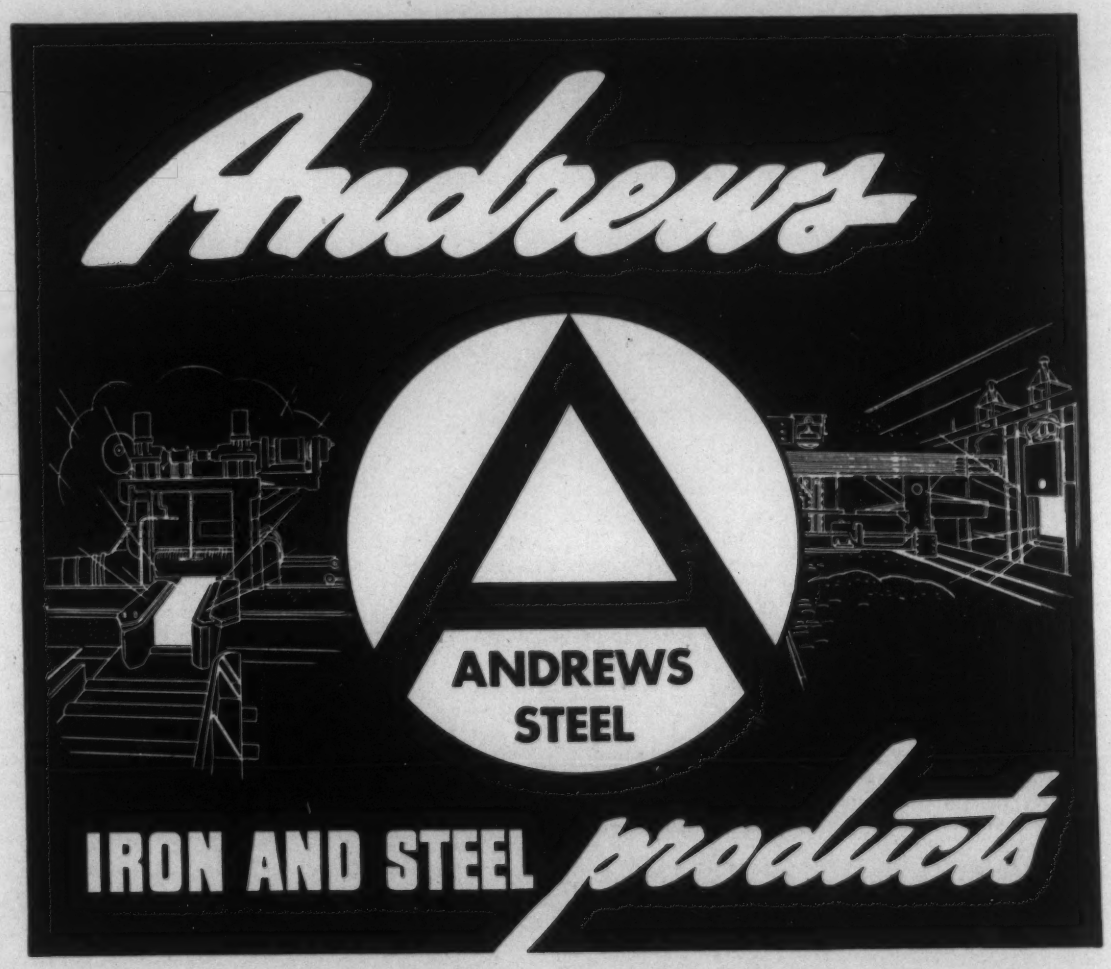


Detects Pinholes in Sheet Metal

Holes as small as one-third the size of a pinhole are detected in a yard-wide ribbon of thin sheet steel racing from an ultra-modern sheet mill through a machine at speeds up to 1000 ft. per min. A row of phototubes ceaselessly scans the sheet for holes, and makes a conspicuous mark by each. In a minute sufficient sheet is scanned by this new Westinghouse device to make 5,000 cans for soup, milk or beer.

Inspection of tin-plate steel for holes has been a troublesome problem. In rolling steel to almost paper thinness, some thin spots and small holes are inevitable. Some holes are almost too small to be seen, yet are too large to be covered over in the eventual tinning process. Cans containing holes mean not only loss of the product canned, but possible damage to other goods in shipment.

Not alone feasible for steel sheet, the "pinhole" detector may be used for other materials such as metals, plastics, or opaque materials, such as rubber-coated cloth.



After all, steel making at its best is a precision art in which the most important factor is man power. There's a knack to steel making that only the years can bring and only long experience sharpen. Here at Andrews we pride ourselves on our men and their superior steel making abilities. Every slab, bar, bloom or billet that leaves this plant bears the unmistakable imprint of each man's skill and craftsmanship. To select Andrews for your requirements is to make sure of two major essentials: (1) iron and steel products of unsurpassed quality, and (2) a wholly dependable source of supply.

In Carbon and Alloy Steels: Blooms • Forging Billets • Rerolling Billets • Slabs • Universal Mill Plates • Sheet Bars

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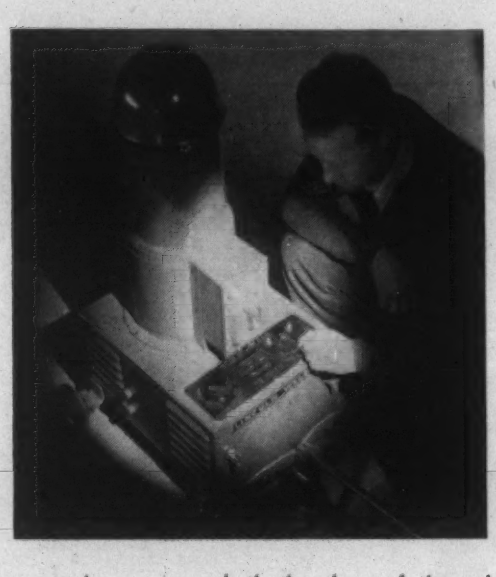
THE GLOBE IRON ROOFING & CORRUGATING CO.

Small Arc Welder with Self-Indicating Dual Continuous Control

A small motor-generator type arc welder, said to provide greater convenience and accuracy in welding because of a new self-indicating dual continuous current control, is announced by The Lincoln Electric Co., Cleveland. Because of its advanced features and moderate price, this unit is expected to widen the application of welding in new fields such as garages, bus and truck fleet repair shops, sheet metal shops, and so on.

The welder, known as the "SA-150", has both job selector and current control calibrated and equipped with dials which indicate the type of work and number of amperes for each and every setting. It is claimed that this development enables the welding operator to secure highest quality welds and highest possible welding speeds



because he can vary both the slope of the volt-ampere curve and the amount of welding current independently and positively to suit every job encountered.

The SA-150, despite its moderate size, has a large number of welding applications within its scope. At the lower part of its range, the welder delivers a current of light-penetration characteristics for the welding of extremely light-gauge material. At the upper portion of its range it delivers ample current for the speedy welding of heavier materials. Complete absence of inflammable materials, such as cotton, linen, fiber, wood, bakelite, etc., enables the machine to withstand sustained operation under overload conditions. Connections are readily accessible for either 220 or 440 volts, 3 or 2-phase, 60 or 50 cycles as desired; the machine can be supplied for 550 volts or special voltages.

The new welder's self-indicating dual continuous control, available for the first time in so small a unit, its uniform welding current of high responsiveness for a speedy welding of all metals and alloys, make the SA-150 an ideal unit for installations where handy portability and versatility are requisite. Increased use of welding has also been furthered by making available similar machines in 75 and 100 ampere sizes.

Electrode for Transformer Welders

A new arc welding electrode for use with alternating current transformer type welders which have low open circuit voltage is announced by The Lincoln Electric Co., Cleveland. The new electrode, known as "Readyweld", is a low-carbon steel rod with a heavy extruded shielded arc coating possessing properties which assure arc stability and easy re-striking of the arc with small low-voltage transformer welders.

Readyweld is intended for general welding and repair work on light gage sheet steel. The electrode provides weld metal which possesses high strength and ductility. Because of its desirable arc characteristics, the electrode is said to permit easier and better welding in the type of work for which it has been developed.

Although designed primarily for use with alternating current transformer welders of low open-circuit voltage, Readyweld also operates well with direct current negative plants. The electrode is manufactured in 3/32 in. dia., 12-in. lengths, packed in 25-lb. containers.

Portable Automatic Gas Analyzer

To meet an insistent demand for a gas analyzer that anybody could use, that would stand transporting and possible rough handling and that yet would be sufficiently accurate for all practical test purposes, the Orsatomat has been developed by the Hays Corp., Michigan City, Ind. It is said to be ideal for traveling installation and service engineers and for general gas analysis—for example, of heat-treating atmospheres—at separated points around a plant.

The Orsatomat is described as a thoroughly reliable Orsat type of gas analyzer, revolutionary in design and without fragile glass parts to break or intricate mechanical or electrical parts to clog or get out of order. Unlike the usual type of Orsat the Orsatomat requires no valve manipulation, no leveling, no burette readings. To simple movements of a rod are all that is necessary to secure an analysis—the result is indicated by the position of a needle on a large, legible scale.

Two models are offered—one for CO_2 only, another for CO_2 and O_2. A special model is also offered for use in the automotive field for testing exhaust gases. Flue gas models may be had with draft and temperature measuring elements.

The Hays Orsatomat is a true Orsat as it adheres strictly to the principle of volumetric measurement and chemical absorption. The sample of gas to be analyzed is aspirated from a point in the line to the measuring chamber by means of an aspirator bulb. When sample has been secured, a rod is pushed down, causing the analyzing body to tilt. As the analyzing body is tilted, mercury flows from a reservoir into the measuring chamber, displacing the sample and forcing it into the absorption chamber, which is filled with metal wool saturated with Cardisorber (a CO_2 absorbing chemical). Here the CO_2 in the gas sample is absorbed, causing a vacuum through the shrinkage in volume. This vacuum or suction is transmitted through metallic bellows to a large pointer which indicates the CO_2 percentage on the scale at the front of the instrument. The same dial has a scale showing draft measurement in inches of water.

Metallographic Cleaner

A new metallographic cleaner has been developed by The Enthone Co., 442 Elm St., New Haven, Conn., which is claimed to assist in preparation of scratch-free metal specimens for microscopic examination. The cleaner is said to be a liquid with high penetrating power which will wet and remove solid particles of abrasive or metal particles formed during the polishing of the specimens. The liquid is self-emulsifying and can be completely rinsed in cold water carrying off all solid particles leaving a clean, dirt-free surface.

The cleaner is also used to wash the polishing cloths removing all particles of dust, minute metal chips or abrasive thus avoiding all danger of scratches in the metallographic specimens from these sources and preventing the cloths from smearing or loading. The metallographic cleaner is particularly valuable for cleaning metallographic specimens being polished on emery papers using kerosene or paraffin as a lubricant. The cleaner penetrates these lubricants and when washed off in water will carry off the lubricant and all solid dirt.

Inasmuch as the presence of only a few coarse particles will spoil the most careful workmanship in metallographic polishing, soap and plain water rinsing have been found inadequate because of their inability to remove all solid particles from the specimens being polished, the polishing cloth discs, or the operator's hands.

"Enthone Metallographic Cleaner" is claimed by the manufacturer to have proved its ability on practical trials to insure perfect preparation of metallographic specimens. The cleaner has no etching action on metals including magnesium, aluminum, zinc, copper, iron or their alloys. It is used simply by brushing it on the specimens or squirting it on with an oil can and then rinsing in running water which is said to remove the cleaner and all solid dirt.

Portable X-Ray Machine

The latest weapon in the inevitably victorious campaign against flaws in industrial products, a 220-kv portable X-ray flaw detector was recently placed in service in examining structural welds and heavy castings on production lines at the East Pittsburgh works of the Westinghouse Electric & Mfg. Co.

The technique of radiographic diagnosis of large steel parts is expected to be much simplified by this 4500-lb. portable X-ray camera, since it may be wheeled along production lines to maintain the quality of machines during their manufacture.

Shockproof, completely self-contained, ready for work wherever there is a proper power supply, it generates X-rays with a penetrating quality sufficient for them to pass through 3 in. of solid steel. The focusing mechanism on the new equipment is extremely flexible, so that the apparatus may be aimed at a weld or casting in either a horizontal or vertical position.

X-ray tube, transformer, capacitors, and flexible focusing device are all compactly mounted on a chassis with four balloon tires, automobile springs, and two-wheel mechanical brakes, enabling two men to move the apparatus in safety.

"Magnilite"—Daylight Plus Magnification

The "Magnilite", developed by Mizzy, Inc., 105 East 16th St., New York City, designed for tool and die makers and machinists, is said to be also the perfect, practical solution for many inspection problems in the factory, as it is detachable from stand and can be used in any given position. The new light concentrates pure daylight rays on the object being inspected which in turn is viewed under magnification from above. Inspection efficiency is substantially increased, caliper readings more easily determined, and eye strain is eliminated. The Magnilite is attached to the base on a universal joint and permits adjustment into any desired position.

Current Metallurgical Abstracts

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MAY, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

1·ORE CONCENTRATION

Crushing, Grinding, Plant Handling, Gravity Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

JOHN ATTWOOD, SECTION EDITOR

Some Studies on the Gold-dissolution Rate in Cyanide Solutions. A. W. FAHRENWALD & JOS. NEWTON (Univ. Idaho) *Eng. Mining J.*, Vol. 140, Jan. 1939, pp. 44-46, 47. The effect of certain variables are studied in a series of experiments. These studies are discussed from the following angles: (1) The effect of simultaneous variation of cyanide and O content on the dissolution of Au from Au foil; (2) the effect of varying O pressure on the dissolution of Au from siliceous Au ores; and (3) the effect of various alkalies on the rate of dissolution of Au from a siliceous ore. Conclusions drawn from the present investigation are: (1) the rate of dissolution of Au from Au foil is directly proportional to the pressure of the O, provided the cyanide strength of the solution is increased in the same ratio as the O pressure; (2) the rate of dissolution of Au from Au ore does not increase in proportion to the O pressure in solutions of constant cyanide strength, but it tends to increase rapidly at first, reach a maximum and then diminish again; (3) as a rule, the cyanide loss tends to decrease at first and then rise again; and (4) the effects of caustic soda, soda ash and sodium phosphate on the extraction are all about the same, while lime and sodium sulphide decrease the rate of dissolution very markedly. The pH cannot be the principal factor that causes the decrease in solution rate; also, cyanide loss and rate of dissolution are not directly connected. WHB (1)

Gold Mining and Milling in Idaho County, Idaho. S. H. LORAIN. *U. S. Bur. Mines Information Circ.* No. 7039, Dec. 1938, 90 pp. At the Lone Pine mine, Au recovery up to 1937 was 97% by amalgamation, using an unusual flow sheet. Costs were $4.114/ton. At the Orogrande-Friscoe mine, sands are leached and slimes agitated in a straight cyanidation circuit giving 80-83% recovery at a cost of $0.3181/ton. At the Gnome mine, 91-92% recovery was secured by straight cyanidation of the oxidized ore; this dropped to 80% when the unoxidized ore was reached. Costs were $3.84/ton. At the Mammoth mine, the ore is floated in a new mill using Barrett No. 4 oil and pine oil (90-10% mixture) in the ball mill and ethyl xanthate and soap reagent in the rougher cells. At the Robinson mine, the ore passes over a blanket table to flotation. After a light roast, concentrates are cyanided. Extraction is 98%. At the Golden Anchor mill, recovery by amalgamation of jig and table concentrates is 75. 64% by flotation 17.39% more—93% in all. Costs are $2.70/ton. At the Snowshoe mill, a flotation concentrate is produced containing $200 of Au/ton. Flow sheets and metallurgical details are given for the foregoing. Many other mills are described briefly. See *Metals and Alloys*, Vol. 9, Dec. 1938, p. MA 700 L/5. AHE (1)

Copper and Antimony in Cyanidation. M. W. VON BERNEWITZ. *U. S. Bur. Mines, Rept. of Investigations* No. 3425, Dec. 1938, pp. 25-28. Ores containing up to 0.5% Cu soluble in cyanide may be treated with NaCN in acid solution without high cyanide consumption; 80% of the cyanide used in dissolution of Cu can be regenerated. Use of strong cyanide solution or addition of soluble Pb salts prevents deposition of Cu on Zn shavings. There is no problem from Cu precipitation if Zn dust is used. Excess Cu in the precipitate may be reduced to 4% by treatment with hot H_2SO_4 and MnO_2. Crude bullion may be refined by blowing air over the surface or by chlorination of the molten metal. Some ores containing stibnite respond favorably to a rapid roast at 810° F. and the addition of CaO to the calcine with a 3-day conditioning, followed by cyanidation. Flotation followed by roasting and cyanidation has given even better results. Tailings containing stibnite and Au respond to cyanidation when a suitable amount of air-slaked lime was used for neutralization. AHE (1)

Ore-testing Studies: Precious-metals Section. E. S. LEAVER & STAFF. *U. S. Bur. Mines Dept. of Investigations* No. 3425, Dec. 1938, pp. 43-83. Details of concentration and extraction tests on the following are reported: Au ore from Ga., Ala., Id., S. D., Ore. and Nev.; Au-Ag ore from Mont., Utah, Id., Calif. and Nev.; Au-Ag-Pb ore from Mont.; Pb-Ag ore from Nev.; Ag-Pb-Zn ore from Colo.; Au-Ag-Cu ore from Mont.; and W ore from Nev. AHE (1)

The Microscope in Ore Testing. R. E. HEAD. *U. S. Bur. Mines Rept. of Investigations* No. 3425, Dec. 1938, pp. 7-14. Microscopic examination serves as an important complement to chemical analysis in interpreting the percentage composition of an ore in terms of minerals. If an ore is difficult to treat, reasons therefore and indicated procedures to overcome the trouble may be ascertained microscopically. Failures in flotation in 4 cases have been traced to (a) intensely intimate mineral association and (b) changes in normal mineral floatability due to the action of products of incipient oxidation. Surface stains and tarnish and the presence of adhering slime particles have been found to be responsible for the difficulty experienced in the treatment of certain Au ores. AHE (1)

Treatment of Arsenical Gold Ores. J. A. WOOLF & T. A. JACKSON. *U. S. Bur. Mines Rept. of Investigations* No. 3425, Dec. 1938, pp. 15-24. Descriptive. Most arsenical Au ores do not respond to simple treatments such as flotation, amalgamation, direct cyanidation, or a combination thereof. Treatment methods include: (1) Low temperature (550° or less), (2) high temperature (600°-725°) oxidizing roast followed by cyanidation of the calcine, (3) preliminary treatment of the calcines from the high temperature oxidizing roast with weak H_2SO_4 solution followed by cyanidation of the residue, (4) a partial sulphating roast followed by cyanidation either direct or preceded by H_2O wash, and (5) fine grinding and flotation followed by roasting of the tailing and direct cyanidation of the calcine. AHF (1)

Recent Results in Magnetic Roasting of Brown Clay Iron Ores (Neue Ergebnisse bei der magnetischen Röstung von Brauneisenerzen) W. LUYKEN & G. KREMER. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf*, Vol. 20, No. 21, 1938, pp. 292-301. Research. A report is made on the results of roasting Fe-poor ores of different origin, which, besides 23.9-24.6% Fe, contained 28-56% SiO_2 and 3-11% Al_2O_3 and smaller percentages of Mn, CaO, MgO, CO_2. The roasting process increased the Fe content in the concentrate to 49.6%, and the yield of Fe was 86%. A special advantage of the roasting process was that 18-28% of the As content was driven off; the subsequent magnetic separation removed about 24% more. 5 references. Ha (1)

Ore-testing Studies: Ore-dressing Section. A. L. ENGEL & MORRIS GUGGENHEIM. *U. S. Bur. Mines Rept. of Investigations* No. 3425, Dec. 1938, pp. 85-104. Details of concentration tests on the following ores are reported: Sn from S. D. and Nev.; Mn from Texas and the Philippine Islands; Ti from Nev. and Ark.; barite from Mo. and Calif.; kyanite from Nev. and Ariz.; feldspar from S.D., N. H. and Conn.; fluorspar from Ky.; Pb-Zn-fluorspar from Ill. and Ky.; pyrite in coal-mine waste from Ill.; a sulphide ore from Calif.; and Cu from the Philippine Islands. See also *Metals and Alloys*, Vol. 8, July 1937, p. MA 408L/2. AHE (1)

Chlorination of Lean Oxidized Nickel Ores by Elementary Chlorine. A. E. BERDNIKOV. *Tsvetnye Metall.*, No. 9, Sept. 1938, pp. 91-94. In Russian. Research. Laboratory experiments showed the feasibility of extraction of Ni from oxidized ores containing 1% Ni or less. The recovery of 78 to 82% of the Ni is possible. The consumption of reducer (coal or charcoal) is equal to 20-25% of the weight of the ore. If Co is present in the ore, it is converted to chloride, together with the Ni, and can be easily separated from the solution. Only 3 or 4% of the Ural Ni ores (with Ni content above 1%) can be extracted by pyrometallurgical methods; the chlorination method is, therefore, of great promise in the treatment of the lean Ni ores. BND (1)

Treatment of Mill Water for Flotation. A. L. ENGEL & MORRIS GUGGENHEIM. *U. S. Bur. Mines Rept. of Investigations* No. 3425, Dec. 1938, pp. 29-31. Not only is it necessary to remove excess soluble salts from mill water by chemical treatment, but the H-ion concentration may also have to be adjusted to effect the desired separation. Treatment must counteract soluble salts in water, salts dissolved from ore, and Fe salts introduced in grinding with Fe balls. A specific case involving flotation of descloizite is described. AHE (1)

2·REDUCTION

Blast Furnace Practice, Smelting and Electro-refining.

A. H. EMERY, SECTION EDITOR

2a. Ferrous

Fundamentals of the Production of High-manganese Slags from Spiegeleisen and Phosphorus-spiegeleisen (Unterlagen zur Gewinnung manganreicher Schlacken aus Spiegeleisen und Phosphorspielgeleisen) W. OELSEN. *Stahl u. Eisen,* Vol. 59, Jan. 26, 1939, pp. 81-87. Original research. Open-hearth slags can be smelted in the blast furnace to give a P spiegel with about 16% Mn and 2% P. From such high-C spiegel, a Mn-rich slag can in turn be produced by oxidation. Various oxidation methods were studied using small melts. Experiments with the slagging of Mn by additions of FeS at temperatures above 1600° C. are described. The effect of Mn and S in the bath on the Mn:Fe ratio in the slag is shown by graphs. As the Mn in the bath goes up to 2%, the Mn in the slag increases rapidly. When treating spiegel with oxide-sulphide mixes, the Si is naturally slagged before the Mn so that the ratio SiO_2:Mn in the slag is determined by the Si:Mn ratio in the spiegel. Because of the strong fluxing action of SiO_2 on MnO, less sulphide goes to the slag as the SiO_2 increases. Without sulphide additions, and by using SiO_2 as a flux at 1350°-1450° C., Mn-rich slags with fairly low SiO_2:Mn can be obtained. This is especially important in obtaining Mn-rich slags from Si-rich spiegel. In low-Si spiegel, the fluxing of the slag, in the absence of SiO_2, can be accomplished by the addition of Fe-Mn ores high in SiO_2. For obtaining Mn-rich slags from P spiegel, the behavior of P during the oxidation of Mn was studied. The oxidation of P decreases with increasing Mn content of the bath and also with increasing sulphide and SiO_2 content of the slag. By slagging Mn in stages, a more favorable Mn:Fe ratio in the slag was obtained, and with P spiegel a lower slagging of P. The effect of such oxidation agents as $CaSO_4$, Na_2SO_4, $FeSO_4$ and $BaSO_4$ is also discussed SE (2a)

Reduction of Iron Ores under Pressure by Hydrogen. MICHAEL TENENBAUM & T. L. JOSEPH (Univ. Minn.) *Metals Tech.,* Vol. 6, Jan. 1939, T.P. No. 1011, 13 pp. Original research. A number of cubes of Fe ore were reduced by H under comparable conditions at several pressures. Pressures greater than 10 in. of Hg materially increased the rate of reduction. This increased reaction velocity was not so great at 600° or 700° C. as it was at 800° C. Both of these results are in agreement with conclusions reached from theoretical considerations given in the paper. JLG (2a)

Construction of Modern Blast Furnace Stoves (Construction des Appareils "Cowper" Modernes) D. PETIT. *Rev. Mét.,* Vol. 35, Nov. 1938, pp. 477-494; Dec. 1938, pp. 544-561. A very detailed discussion is given of the construction of blast furnace stoves. The types are: (1) Constant section, such as Cockerill, which is most used in Europe with tubes fitted into each other; (2) zoned stoves with circular, hexagonal, square (or square with divisions, such as Brassert) sections; (3) turbulent, such as Wabenstein, used in Germany. Refractories are used more than castings, since the former have lower cost and weight, although the latter give more rapid heat transfer. JZB (2a)

Inland Steel Co. Honors Founders in Lighting 1000-ton Blast Furnace. *Iron Age,* Vol. 143, Jan. 12, 1939, pp. 40-41. Description of a new blast furnace. Unusual feature is the crank action of operating bell mechanism instead of the conventional bell beam. Stoves are 26 ft. in diameter and 110 ft. high. Each stove has about 200,000 sq. ft. of heating surface and 50 sq. ft. of combustion chamber. Freyn burners use 22,500 cu. ft. of gas/min. The stack has 14 tuyeres and 7 columns, and the hearth diameter is 25 ft. VSP (2a)

Combustion in the Atmosphere of Surplus Blast Furnace Gas in Metallurgical Factories (La Combustion dans l'Atmosphère des Excédents de Gaz de Hauts-Fourneaux dans les Usines Métallurgiques) L. POUPET & R. CHAURAND. *Rev. Mét.,* Vol. 35, Dec. 1938, pp. 525-530. Practical. French law prohibits release of blast furnace gas with over 1.5-2 g./cm. dust and over 1% CO. Surplus gas (refined to meet the above requirements) was burned in large automatic burners at Acieries de Longwy. JZB (2a)

2b. Non-Ferrous

The Thermal Reduction of Roasted Zinc Sulfide and the Condensation of Zinc (Untersuchungen über die thermische Reduktion von Röstblende und die Kondensation von Zink) G. GRILLO. *Metall u. Erz,* Vol. 35, No. 18, 1938, pp. 475-480. Research. The historical development of practice, theories of reduction of Zn blende and the effects of pretreatment of ZnO, of reducing agents and of the physical condition of the material are discussed. The extent to which the efficiency of the Zn muffle is affected by different reducing agents and different degrees of roasting was determined. Cheap coal can be used for reduction without significant difference in yield. Too heavy airing of the condenser chamber lowered the yield, owing to deposition on the walls, and too high a temperature gave oxidation losses. The condenser should be long enough to permit gradual cooling in a large condensation space, yet it must not permit the metal to solidify. A change of wall thickness had a negligible effect on the yield. The greater part of the metal in the vapors is condensed as soon as the gases have cooled below the dew point of the Zn. In order to obtain the remainder in liquid drops, the gases should cool very gradually with very slow flow along (preferably) heated baffles. The dimensions and arrangement of the furnace are, however, of great importance, as is shown by construction details. PCR + Ha (2b)

Zinc Vapor Condensation in Vertical Muffles (Die Zinkdampfverdichtung bei stehenden Muffeln) A. RITZHEIM. *Metall u. Erz,* Vol. 35, No. 20, 1938, pp. 531-539. Research. Owing to the CO_2 formed in Zn ore reduction and carried over to the condenser, a certain amount of oxidation of the Zn vapor occurs. An easily reduced Zn ore reacts with CO to produce CO_2 faster than the CO_2 can be reduced back to CO by C, resulting in a higher concentration of CO_2 in the condenser than with a difficultly reducible ore. Adding more gas to the charge increases the reaction rate without increasing the CO content, which can only be affected by raising the temperature. This, however, affects the surface of the ore and results in increased ZnO and Zn dust. By using a continuous process in a vertical muffle, the gases must pass up through the colder parts of the charge where the ZnO precipitates, and the remaining gases containing Zn vapor continue to the condenser. The use of the continuous process eliminates congestion that might occur from the ZnO precipitate. PCR (2b)

Electrolytic Parting of Gold and Silver, at the Works of the Broken Hill Associated Smelters Pty., Ltd., Port Pirie. F. A. GREEN. *Proc. Australasian Inst. Mining Met.,* No. 107, Sept. 30, 1937, pp. 205-221. The layout, equipment and operating details are described. The electrolyte is a neutral solution of $AgNO_3$ containing 200 g. Ag/l. Ag from the anode plates is deposited on cathode carbons in fine granular form. Ag is raked out every 4 hrs. The anode sludge is melted to a high grade doré bullion that is parted to give a final Au sludge. This is treated with HNO_3 melted, cast, remelted and refined with Cl. AHE (2b)

The Production of Zinc from Zinc Dust through Melting, with Special Reference to the Thede Process (Die Gewinnung von Zink aus Zinkstaub durch Asschmelzen, insbesondere nach dem Thede-Verfahren) J. J. THEDE. *Metall u. Erz,* Vol. 35, No. 12, 1938, pp. 317-321. Descriptive. Zn dust is treated in a rotating externally-heated closed drum kept above the melting point of Zn. The yield is about 95% and the cost about 1/10 that of the distillation process. Economic considerations are discussed. PCR (2b)

The Influence of the Crystalline Structure of Bauxite on Its Decomposition in the Bayer Process (Der Einfluss der Kristallinen Struktur der Bauxit auf ihre Aufschliessbarkeit nach dem Bayer-Verfahren) ALBERT ROTH. *Metall u. Erz,* Vol. 35, No. 17, 1938, pp. 447-450. Original research. Ores having a low yield contained a correspondingly high diaspore content as shown by the Debye-Scherrer method. The lengthy and costly preliminary tests to determine their yield can be eliminated by using X-ray tests. PCR (2b)

3·MELTING, REFINING AND CASTING

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Direct and Continuous Casting Production of Sheet and Bar from Molten Metal. E. R. MORT. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 41-46. Up-to-date review. The production of sheet, rod, tube and strip direct from the molten metal has several very obvious advantages from the economic viewpoint. Attention was first drawn to the method as far back as 1846, when Bessemer patented such a process. Little note was taken of its possibilities until 7 yrs. ago, when Hazelett and Eldred began their work. Two types of processes have been developed, one that manufactures a salable product direct from the molten metal, known as "direct casting," and another that manufactures in indefinite lengths something intermediate between the raw material and the finished product, known as "continuous casting." The *Hazelett process,* a direct casting method, is little different from Bessemer's original idea; in it the molten metal is poured so as to form a lake above the nip of the rolls, which are water cooled. The pouring temperature, diameter and speed of the rolls are critical factors. Three difficulties are encountered: Preferential solidification of the metal on the flanges of the roll, segregation in alloys, and oxidation. At present the process is being used for Pb and Al in strip form. Al strip so produced has a tensile strength of 14,000 lbs./in.^{2} with good ductility. Foil can be produced much more cheaply from this strip than is possible with the conventional method. A great deal of development work has also been carried out on the direct rolling of brass, as yet without success. The process is not at the moment sufficiently advanced to render it a commercial proposition, except under special circumstances. The Hazelett process is confined to the production of strip. The *Eldred process* is especially suitable for the production of wire and rod. The metal is melted in a furnace, in the bottom of which are a number of chambers; beneath them are a die and cooling chamber. Operations are started by inserting a rod into the forming chamber; molten metal congeals on the rod and is drawn through the die. Another continuous process, developed by Kohlhass, is described, but is not being used commercially. Emphasis is placed on the ability to exclude air from the casting groove so that the molten metal is solidified without undue exposure to the atmosphere. The Jungham process is in commercial use. The molten metal is fed through a nozzle into a moving, open, watercooled mold. By accurate control of the speed at which the various parts of the system operate, and by arranging suitable cooling conditions, it is possible to produce a section of infinite length; therefore, the process is of the "continuous" type. Numerous other processes have been offered but few have been tried on a commercial scale. Billets of continuously cast Cu are available in America. The only claims made for these billets are that they are available in any length and have a much superior surface as compared with the ordinary commercial product. The process is apparently operated so as to produce a grain structure as nearly as possible similar to the normal cast structure. RWB (3)

Compression Strength and Shearing Strength of Moulding Sand. B. HOLMAN. *Foundry Trade J.,* Vol. 59, Dec. 8, 1938, pp. 429-431. Original research. Comparison tests were made with 14 types of molding sand of widely varying qualities. The specimens for testing the compression and the shearing strengths are identical in shape, being cylindrical and having a mean height of 2 in. Three specimens were employed in the green state for the cohesion test by determining the compression strength. The tests were made in the Adams apparatus. The other 3 specimens were used for the cohesion tests by determining the shearing strength in the Dietert balance beam apparatus. The following conclusions were reached: (1) The shearing strength is much lower than the compression strength; (2) the reciprocal comparison of the cohesion of the various types of sand is practically the same, whether cohesion is determined on the basis of the compression strength or of the shearing strength; (3) the compression or shearing strength of the green specimens depends in the same way upon the moisture content, *i.e.* both the compression strength and shearing strength diminish with increasing moisture content of the sand; and (4) the compression strength and the shearing strength of the baked specimens increase with increasing moisture content of the specimens when rammed. AIK (3)

Present Status of Molding in Sand Mixed with Cement (Ou en est le Moulage en Sable Aggloméré au Ciment?) *Rev. Fonderie Moderne,* Vol. 32, Nov. 10/25, 1938, pp. 279-283. Review. Development of molding in sand-cement mixtures and present use, especially in France, is described. The greatest disadvantage of the method is the need to allow at least 24-48 hrs. for setting, which is inconvenient, especially for small pieces. The advantages of the method are suppression of heating of the mold and thus lower fuel consumption, better production of castings and simplification of molding owing to greater strength of the material so that supports become less necessary, less danger of scratching and defacing of the molds. The recommended composition is 70% of a siliceous sand (about 98.5% Si) of 60 mesh grain size and as free as possible of clay, 3-15% cement and 2-9% water, mixed together in any good mixer. Examples show molding methods; recovery of sand and preparation of mixtures is described. Ha (3)

Sand Control for Better Castings. H. W. DIETERT. *Metals and Alloys,* Vol. 10, Mar. 1939, pp. 90-95. Practical. The modern foundry controls 4 molding and core sand variables—moisture, permeability, strength and grain fineness; mold hardness and flexibility are also important. Moisture variation in a sand for steel should not exceed 2 points (on a "moisture teller"); 4 points is permissible for gray iron; for non-ferrous castings the tolerance is about 5 points. Permeability ranges for several types of casting are given: Al, 10-15; brass, 12-25; special non-ferrous alloys, up to 90; gray iron, 12-50; steel, 150-200; stainless steel, down to 60. Clay content affects sand strength, flowability and sintering characteristics. Low green strength is usually accompanied by low dry strength, resulting in metal-erosion of the mold surface; excessive strength may cause hot cracks in quick-setting metals. Many illustrations of typical casting and mold defects are shown, and their causes and prevention discussed. FPP (3)

Refinement of the Structure of Castings (Affinage de Structure des Moulages) ALBERT PORTEVIN. *Bull. l'Assoc. Tech. Fonderie,* Vol. 12, Oct. 1938, pp. 253-264. Review of the present status of the question of methods for controlling grain size in cast metals. The fineness of the structure on solidification is influenced by: Agitation of the liquid during freezing, thermal conditions during freezing, thermal history before solidification, repetition of fusions, electrical or magnetic influences, influences of pressure, composition of the alloy and addition of foreign elements, incorporation or precipitation of germs or inclusions and, inversely, decantation or centrifugation, and the action of fluxes or slags. 21 references. WHS (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

Shop Problems in Low Carbon Iron. A. P. LEE (Bethlehem Steel Co.) *Foundry,* Vol. 66, Dec. 1938, pp. 26-27, 72; Vol. 67, Jan. 1939, pp. 28-29, 74. Practical discussion of the use of low C irons, due to their higher strength and other desirable properties. Casting should not be made with lower C than is necessary to produce desired results. Selection of C content for a certain job entails several factors. Most important is the design, thickness of section, use to which casting will be put, strength and machinability. Intelligent utilization of alloys is also important. Other factors of importance are proper gates, risers and head pressure. Defects blamed on metal are often due to slight boil, kick from core, hard ramming, close sand, or insufficient venting. Dry sand core boxes, gates, cores and cleaner gates now are used more extensively. When gating castings of light and heavy sections, it is well, if possible, to gate on the lighter section. The idea is to put hot metal in light section and colder metal in heavy section. Internal and external shrinkage are troublesome. Irons that shrink externally usually are free from internal shrinkage and are very reliable for gears. In certain castings, external shrinkage is as serious as internal shrinkage in others. Most castings have to be machined. Improvements made in technique are considered. VSP (3a)

How Silico-Manganese improves Rimming Steel

WHEN silico-manganese is added to rimming steel shortly before tapping, a cleaner, better steel is produced. The inclusions formed have appreciably lower melting points and are of a modified type. Results indicate that this modified type of inclusion decreases the age-hardening tendency of rimming steel. In addition, this silico-manganese treatment permits a reduction in the use of other deoxidizers that lead to objectionable inclusions.

Ask to have one of our metallurgists call and explain more fully the advantages of silico-manganese for producing rimming steel. He will gladly help make your use of this and other "Electromet" ferro-alloys more profitable, without obligation. Electro Metallurgical Company, Unit of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York, N. Y. In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

Items of Interest about other "Electromet" Ferro-Alloys

Vanadium Improves Steel Castings — The addition of a small amount of vanadium, usually not over 0.10 per cent, to steel castings refines grain, materially raises yield-point strength without sacrificing ductility, and greatly increases resistance to shock and fatigue. This is especially useful in engine and railroad car castings.

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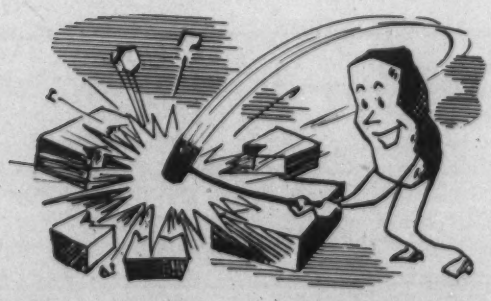

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For Cleaner Steel, Make a Final Addition of Calcium-Manganese-Silicon—Calcium-manganese-silicon, used as a final alloy addition to steel, produces a cleaner, coarse-grained steel with deep-

hardening properties. Long commercial use of this combination alloy has proved its merits for this purpose. Calcium-manganese-silicon is also being successfully used to deoxidize all types of stainless steel, high-speed tool steels, and special steels subject to transverse testing.

Zirconium Inhibits Carbon Segregation — Zirconium added to killed steel in the ladle diminishes the variation in carbon content within the ingot. By thus inhibiting carbon segregation, zirconium makes grain structure and properties more uniform throughout the ingot.

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PRODUCTS OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

What We Do Not Know about Cast Iron. J. E. HURST. *Foundry Trade J.*, Vol. 59, Nov. 24, 1938, pp. 387, 388, 391. Survey. The complex phenomenon of graphitization still remains imperfectly understood. In it there still lies much of "what we do not know about cast iron." New light has been shed on the subject through the better understanding of the crystal structure of Fe-C alloys that has come with the application of X-ray analysis; by the study of the effects of superheating; by investigation of the conditions controlling the size and refinement of the graphite; and through the discovery of the effect of particles of undissolved impurities and dissolved gases in the cast iron. The exact nature, character and properties of cast iron completely free from dissolved gases and from insoluble particles of slag is still undefined. The study of segregation phenomena in cast iron has been somewhat neglected. Such studies have proved of value in helping to understand the mechanism of solidification of steel, and it is believed that similar investigations applied to cast iron would prove equally helpful. When suitable cast irons are subjected to hardening treatment by heating to temperatures above the A_3 point and quenched in water or oil, an increase in hardness, accompanied by a marked drop in tensile strength, results. Tempering the quench-hardened specimens is accompanied by a recovery in ultimate strength, and all investigations show that this recovery increases uniformly with increasing tempering temperature until a maximum is reached, followed by a decline with still further increment in tempering temperature. The magnitude of this recovery in strength value can be very large and strength values 50% greater than the original "as cast" value have been recorded. However, we know much less about the metallography of hardening and tempering cast iron than we do in the case of steels. With regard to malleable iron, the author refers to the lack of knowledge of the effect of further heat treatment for such purposes as refining grain structure. The discovery and application of other forms of heat treatment to cast iron still remain a possibility. The application of the N-hardening process is a case in point, and whereas this and the flame-hardening method, such as is used in the Shorter process, have been developed as a means of surface hardening cast iron, we know very little about other methods of case-hardening applied to cast iron. We do not know how to produce directly cast iron that will bend (without the difficulties of the white iron stage and, perhaps, without the difficulties associated with the annealing treatments). It is now realized that cast irons really do possess elastic properties, and these properties are usefully applied when cast iron is employed for such things as piston rings, valve seat inserts, cylinder liners, etc., yet we know little about the conditions of composition, structural character, etc., that influence the elastic properties. AIK (3a)

Solidification of Rimming Steel Ingots (Stelningsförlopp och struktur i göt av otätat stål) A. HULTGREN & G. PHRAGMÉN. *Jernkontorets Ann.*, Vol. 122, No. 8, 1938, pp. 377-465. Research. The observations and views of previous investigations on rimming steel ingots were reviewed, with particular reference to the nature of the gases liberated on freezing and on the structure and composition of the steel. The laws of freezing for steel of various C and Mn contents were deduced from a tentative Fe-C-O diagram. As long as gas is freely evolved during freezing, the C and O concentrations remain unaltered in the liquid as a consequence of the reaction between dissolved O and dissolved C to give CO and CO_2. The composition is about 0.06% C and 0.04% O at equilibrium. After the top of the ingot is closed, gas is evolved in limited quantities due to shrinkage, but the pressure gradually increases. The results are illustrated by numerous tables and 50 photographs showing primary structures, blowholes and segregates. The distribution of C, P, S and O has been determined and agree well with the distribution expected from the equilibrium diagram. Practical conclusions noted are that air oxidation during rimming reduces the C content, with consequent lowering of the final pressure. High pouring temperatures retard the cooling; thus there are fewer gas bubbles and a thinner skin. Conversely, a low pouring temperature causes more vigorous gas evolution, owing to more rapid freezing. In slow pouring, the lower portion solidifies under lower hydrostatic pressure, resulting in a thicker skin than is normally expected. Under-oxidation also tends to make a thinner skin. Swinging of the ingot during rimming may cause considerable agitation and increase segregation. HCD (3a)

Influence of Chemical Composition on Internal Seams in Axle Steel. M. MEDJHIBOJHSKI. *Teoria i Pract. Met.*, No. 7-8, 1938, pp. 31-36. In Russian. Statistical study of about 400 production heats (the type of furnaces used is not specified) showed that a higher content of Si and Mn leads to more internal seams; increasing carbon reduces the number; and S, within commercial specifications, does not affect seams at all. Effect of Al on seams depends not only on its own content but of Si and Mn as well. With 0.3% Si and 0.7% Mn, Al addition to the ladle should vary between 0.027 and 0.032%, and with 0.15-0.20% Si and 0.5-0.6% Mn a steel can stand 0.04-0.05% Al. (3a)

Making a Large Lathe Bed. WILLIAM Y. BUCHANAN. *Foundry Trade J.*, Vol. 59, Dec. 15, 1938, pp. 441-444. Descriptive. The casting described is a lathe bed of constant cross-section, in varying lengths. The usual length is 33 ft.; in some cases it is 40 ft., when it is jointed in 2 sections. All 97 castings were made in the manner described. Method of pattern construction, molding flask, molding, ramming, head-end core, body cores, gate dimensions, rate of castings, lifting, precautions and possible defects, use of chills or denseners, metal control and composition, etc., are discussed. There are presented very interesting graphs, showing the relation between graphite length and analysis in 81 castings, relation between graphite length and melting conditions (tapping temperature, casting temperature, melting rate, charge of coke), Brinell hardness, etc., and relation between graphite length and type and percentage of raw materials in cupola charge. This casting is best cast quickly, and the rate used for those referred to is 6 tons per minute. The object is to cover the bottom and fill the shears as quickly as possible, but, as there is a relatively light section above this, with rapid filling, the metal is certain to rise too quickly toward the top and may strike the top of the mold with considerable force. The use of 3 ladles is preferred to, say, one large ladle collecting all the metal, as this cannot give such uniform cooling conditions. With 3 ladles and a continuous tapping system, the metal can be conveniently collected and cast with no more than 20° or 30° C. difference in temperature. By starting all 3 ladles together, and allowing one to empty early, the rapid filling of the lower heavy section can be accomplished with a somewhat slower filling of the lighter upper sections of the mold. If this rate is not checked toward the end, a small quantity of metal is shot up to the roof, which, although it does no harm to the mold, is very annoying to those who have to be near. No chilling is done on the surface of these beds, and the hardness obtained by the proper composition and melting conditions has a very high uniformity in heavy sections. A casting made in this way is much less subject to strains. A surface that would be described by the machinist as open is associated with graphite length of 0.050 in. and often with free ferrite. AIK (3a)

High-duty Cast Iron. J. ARNOTT. *Foundry Trade J.*, Vol. 59, Dec. 15, 1938, pp. 447, 450. Review plus original research. High-duty cast iron may be defined as cast iron having a dependable strength of over 40,000 lbs./in.^{2} High-strength cast iron can be made in various ways, by direct cupola melting, duplexing in electric furnaces, cold melting in oil or electric furnaces, etc. The relation of the total C to strength indicates that strengths of over 40,000 lbs./in.^{2} are obtained if the total C is under a figure of approximately 3.1%. Beyond this C content, the strength falls away rapidly. Ni and Mo together give promise of properties that are attractive in many directions. Strength of 60,000 lbs./in.^{2} and upwards were obtained from melts containing: total C, 2.6-2.8; Si, 1.5-2.0; Ni, 2.0; and Mo, 0.5%. A feature of this type is the very good impact resistance. The final aim is to use the cupola for ordinary production wherever possible. The author found that, comparing electric furnace melts with cupola melts, similar properties were obtained with similar compositions. No advantage was found from superheating in the electric furnace, or duplexing of cupola-melted metal. Iron of composition whithin the limits total C 2.6-2.9, Si 1.3-2.3, and Ni 1.4-2.0% gives an average tensile strength of 48,000 lbs./in.^{2} on 1.2 in. bars cast separately. On bars "cast-on" to castings and submitted, while still attached, to a low-temperature stress-relief anneal, the tensile strength has been found to be consistently about 2 ton/in.^{2} higher then on separately-cast bars. In regular production, many tests exceed 56,000 lbs./in.^{2} In castings of varying section, the uniformity of Fe of this type is excellent. The Brinell hardness of the 1.2-in. bar lies between 260 and 300, yet the castings machine without difficulty. Low total C irons retain their strength well at medium temperatures. Bars from 5 experimental melts, on a short time test at 450° C., showed an average retention of over 90% of the room temperature strength. The number of possible combinations of Cu, Ni, Cr and Mo is immense. AIK (3a)

Chilled Iron and Other Rolls. A. ALLISON. *Foundry Trade J.*, Vol. 59, Nov. 17, 1938, pp. 369, 370, 372. Review. Chill formation, the "Pb-contact" process, alloy rolls, low-C rolls, method of melting, the role of P, alloyed vs. hardened steel rolls, etc. are discussed. It is possible to increase hardness in plain chill by maintaining metallic contact between the roll and the mold. This is the subject of a patent by the Metropolitan-Vickers Co., Ltd., and the process consists of injecting molten Pb very soon after casting into the space produced by natural contraction. It is believed that with metal kept molten for some time on a hearth, there will more likely be a more perfect mixture and solution of elements than with Fe, say, melted in the cupola. A roll breaks from the combined effect of residual casting stresses, heat stresses and mechanical stresses. It is believed that casting stresses are relieved at a temperature of 500° C., and some softening occurs that may be advantageous. AIK (3a)

Spheroidized Pearlitic Malleable. DUNCAN P. FORBES (Gunite Foundries Corp.) *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Dec. 1938, pp. 491-507. Only recently has much attention been given to the production of commercially valuable pearlitic malleable. This paper considers the effect of the graphite-retarding element Mn in spheroidized pearlitic malleable. Commercially, a suitable white iron is prepared of an analysis typified by the following: Total C 2.43%; Si 1.03%; Mn 0.34%; S 0.08%; and P 0.15%. At the time the Fe is tapped into the pouring ladle, an addition of ferromanganese is made to increase the Mn content to the percentage desired. After the castings have been poured, they are cleaned and subjected to heat treatment. In the production of spheroidized pearlitic malleable, it is possible to have a wide variety of properties. In fact, with pearlitic malleable iron, it is possible to duplicate almost any grade of steel, with the presence of temper C as the important difference. A variation in the Mn content of the material has little if any effect on the limit of solubility of combined C in austenite in the presence of temper C. The combined C percentage, remaining in the material after the spheroidizing operation, is increased with higher percentages of Mn. With increased combined C content, or with increase in Mn, the ultimate tensile strength and the yield strength are increased, while the percentage of elongation is decreased.
CEJ (3a)

Various Cupola Constructions (Die verschiedenen Bauarten von Kupolöfen) *Giessereipraxis*, Vol. 59, Nov. 20, 1938, pp. 478-481; Dec. 4, 1938, pp. 495-499. Practical. Excellent melting results can be attained in cupolas of simplest construction, if proper service conditions are provided. An historical account of cupola construction is given, describing the cupolas of Ireland, and of Greiner-Schopf with spiral-arranged blast nozzles, and the Poumay cupola with a double row of nozzles. The essential advantages of the Poumay method—decrease of coke consumption and increased melting capacity—are not due to the particular nozzle arrangement but to the increase of blowing cross-section thereby effected. Therefore, the same result can be attained in other cupola designs by increasing the blowing cross section, which should amount to 1/5-1/6 of the cupola cross-section. Important future improvements in regard to nozzle type and blast supply are not to be expected. Other types of cupolas, such as those with additional oil firing, with heated forehearth, slag separator, or refining hearth are critically considered. It is doubted that the present status of efficiency in cupola melting can be surpassed, *i.e.* 6-8% of burden coke in melting gray cast Fe and 10-12% coke in melting malleable cast Fe. Also, further improvements in quality of cupola Fe are doubted.
GN (3a)

Silicon Carbide Additions to Cast Iron. JOHN A. BOYER. *Metals and Alloys*, Vol. 10, Jan. 1939, pp. 8-12; Feb. 1939, pp. 59-63. Original research. Based on metallographic study of many samples of cast iron, the thesis is presented that the addition of Si and C as SiC results in a higher quality iron than that produced with the customary Si and C additions. With irons low in P, a charge that would normally result in a white iron can be treated with about 1% SiC to produce a machinable gray iron with tensile strength over 40,000 lbs./in.^{2}. With an iron having an intermediate P content, the phosphide complexes—which ordinarily cause hard spots or render an iron made from a high scrap charge difficultly machinable—are broken up without appreciable coarsening of the graphite structure. With a high-P iron, the phosphide eutectic tends to form a cellular network that is usually broken up by a high-C, high-Si and low-S content; with SiC additions, a "harder" charge can be used and more satisfactory physical properties obtained without decreasing machinability. Tests over a period of years have shown improved physical properties, better machinability and certain desirable changes in microstructure over corresponding untreated irons made from high percentages of pig.
FPP (3a)

Produces High Strength Iron. G. A. TIMMONS, V. A. CROSBY & A. J. HERZIG (Climax Molybdenum Co.) *Foundry*, Vol. 66, Dec. 1938, pp. 28-30, 75-76; Vol. 67, Jan. 1939, pp. 30-31, 86, 88. Original investigation of the effect of Mo on super cast Fe. Commercial production of cast Fe in excess of 50,000 lbs./in.^{2} has been one of the most noteworthy achievements of the foundry in recent years. In developing cast Fe in excess of 60,000 lbs./in.^{2} the following considerations must be taken into account: (1) Adjustment of C-Si ratio to produce Fe with low graphitic C without producing ferrite or carbide; (2) using late addition of graphitizers to control graphite distribution, flake size and shape; and (3) introduction of alloys to further assist in balancing the Fe, strengthen matrix through solid solution effect, and control rate of transformation reaction. A detailed description of procedure followed is given, and the results obtained tabulated. Among 15 irons examined 10 developed tensile strength in excess of 70,000 lbs./in.^{2} and 6 showed more than 80,000 lbs./in.^{2}. Includes a number of photomicrographs.
VSP (3a)

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Dual Frequency Steel Furnaces. *Electrical Rev.*, Vol. 123, Aug. 26, 1938, p. 276. Descriptive. Two conical crucible dual frequency furnaces of 5-6 tons capacity built for a Swedish steelworks are designed to permit both melting of steel and its decarburization and refining. Each is built inside a "trunconic" shaped steel casing, surmounted by a cylindrical section that provides extra space above molten metal. A magnetic screen, consisting of a series of packets of thin sheets held together by clamps, is provided inside the conical portion of the casing. Conductors, composed of H_2O-cooled, thick-walled Cu tubes covered with a special ceramic insulation insensitive to temperature differences, are laid over this screen. There is no contact between screen and conductors. Crucible, of fire-resisting material about 5 in. thick, is laid over winding and baked to form a thin crust able to support charge. High frequency is 1000 cycles and low frequency 25 cycles. Each can be separately controlled, so that the furnace can be fed either or both at desired voltage and strength. Low-frequency is 3-phase to obtain proper direction of agitation of molten steel, allowing thorough mixing of metal and slag during refining.
MS (3a)

The Behaviour of Sulphur in the Basic Open-hearth Process. D. MANTERFIELD. *Metallurgia*, Vol. 19, Dec. 1938, pp. 55-58. Original research. The behavior of S in 80-ton basic open-hearth furnaces, charged with scrap and cold pig, was studied by analyses of metal and slag during stages of the heat. With a normal slag, containing 50% CaO and 12% SiO_2, the ratio of S in slag to S in metal was approximately 10. Analyses for 46 heats are given. The S lost from the slag is practically equal to that picked up from the gas, so almost all S charged remains in the metal and slag. With high S charges, however, an appreciable amount of S is lost. The less O in the steel and the more basic the slag, the greater is the elimination of S from the metal. A volumetric method for the determination of S in slag is given.
JLG (3a)

Modern Electric Arc Furnaces. ALFRED KARSTEN. *Ind. Chemist*, Vol. 14, Sept. 1938, pp. 349-351, 369. Descriptive. A few furnaces used abroad for the production of ferroalloys, such as the single-phase reduction furnace of the Miguet type, are described. For the manufacture of ferro tungsten with 0.15 to 0.6% C, good results have been obtained with the silico-thermal process in which the ores are reduced by Si, the latter being oxidized to silica and combined with lime to form a slag. RAW (3a)

The Formation of Graphite in Gray Iron. ALFRED BOYLES. *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Dec. 1938, pp. 297-334. Research. In hypoeutectic gray Fe, the graphite flakes form during the freezing of the eutectic and grow radially from the crystallization centers of the eutectic liquid. With a given rate of cooling, the size of the flakes is determined by the rate of graphitization along the solid-liquid interface. S and H in solution in the eutectic liquid decrease the rate of graphitization and the segregation of these elements produces composition gradients around each crystallization center. The amount of sulphide remaining in solution in the eutectic liquid is determined by the extent to which sulphide inclusions have been precipitated in the melt above the eutectic temperature. Mn, by changing the solubility of the sulphide, limits the amount remaining in solution along the solid-liquid interface during the growth of the graphite flakes. An alloy of constant Si and C content can be made to assume a great variety of structures by varying the Mn and S contents and melting under circumstances conducive to a change in the amount of H in solution in the molten metal. These conclusions were based on a study of alloys containing from 3.00 to 3.50% C and about 2.00% Si. CEJ (3a)

Desulphurization of Pig Iron by Burnt Lime in the Stürzelberg Drum Type Furnace (Entschwefelung von Roheisen mit gebranntem Kalk in Stürzelberger Trömmelöfen) W. BADING & A. KRUS. *Stahl u. Eisen*, Vol. 58, Dec. 22, 1938, pp. 1457-1459. Practical. Pig Fe, melted in the Stürzelberg furnace, has been found to be very low in S, mostly under 0.01% S, and this type furnace has, therefore, been tried for desulphurizing pig Fe with burnt lime. After preliminary tests, an extended desulphurization campaign in the Stürzelberg furnace was run with basic Bessemer pig Fe from Huckingen. In one example, the Fe after melt-down contained 0.390% S and, after 120 min. in the Stürzelberg furnace with the addition of burnt lime, the Fe was tapped and contained 0.028% S. The advantages of this method of desulphurization over that with Na_2CO_3 are brought out, an important one being that it is not destructive of refractories. The overall costs of this method of desulphurization, including fuel and furnace costs, are figured to be 0.25 RM./ton pig Fe. SE (3a)

Deoxidation and Graphitization of Cast Iron. R. G. MCELWEE (Vanadium Corp. of America) *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Dec. 1938, pp. 341-349. A means is suggested for the practical foundryman to experiment with those jobs that may be giving trouble due to abrupt changes in structure. Cast Fe may be made more versatile in its use by reducing the effect of different cooling rates in the same casting or other castings from the same pattern. The use of test wedge-shaped casting assists in a logical study of effects of experiments. If the hardener and graphitizer are correctly proportioned to take care of the heaviest section of the casting, the light sections can then be treated by late additions, giving a deoxidizing effect that tends to reduce the chilling without reducing the hardness in the heavy section. CMS (3a)

Roll Manufacture. Grain and Chilled Grades. W. H. LEWIS. *Iron & Coal Trades Rev.*, Vol. 138, Jan. 13, 1939, p. 41. Practical. Service requirements are: (1) Body of rolls must have strength to resist breakage, either by direct load or by stresses due to heat; and (2) the surface must be highly resistant to abrasion and to deformation under high pressure. Roll must withstand local temperature variations that cause cracking or crazing on hot rolling. A high finish, secured by a very hard chill surface, is necessary for cold rolling flat products. Sizes and uses of various rolls are discussed. Most chilled rolls are straight C and low Mo alloy with a surface hardness of 55-65 Shore. High alloy chilled rolls with surface hardness up to 90 Shore are made, using Ni, Cr and Mo. CBJ (3a)

Load Conditions and Electrode Problems in Large Electric Steel Furnaces (Belastningsfoerhallanden och elektrodproblem vid stora elektrostaalugnar) S. VON HOFSTEN. *Tek. Tid.*, Vol. 69, Jan. 14, 1939, pp. 14-17. Practical. Power consumption depends largely upon furnace construction and the melting process used. Of great importance is as much reduction of time between charges as possible. High efficiency may be obtained where several furnaces are used by staggering the operations in such a manner that an even load factor is always obtained. Introduction of Soderberg self-baking electrodes is one of the most important improvements in this field in the last 20 years. They give more quiet smelting, protect the roof from over heating, and lower the energy consumption. BHS (3a)

Effect of Blast Pressure in Cupola Melting. J. T. MACKENZIE & C. K. DONOHO (Am. Cast Iron Pipe Co.) *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Mar. 1939, pp. 513-520. Research. An investigation of the effect of varying blast pressures on cupola melting and on the properties of the resulting Fe. Separate heats were made in a 21-in. test cupola, using a wide range of blast pressures and 2 different kinds of metal charges. Results indicate that blast pressure may be varied widely to change the melting rate, and that, except for slight changes in analysis, the melted Fe will show no undue variations from the normal. CMS (3a)

Fluxing Material and Cupola Refractories (De l'Influence des Fondants sur l'Usure des Refractaires de Cubilot) GUY HÉNON. *La Fonte*, No. 36, Nov.-Dec. 1938, pp. 1315-1329. A very complete study of slags and refractories. As much as 55% of the flux may be used in slagging the refractory lining in the cupola. Self-slagging coke, which is made from coal mixed with fluxing material, is a help in avoiding this attack on the refractory lining. Reducing the thickness of the lining in the melting zone permits radiation cooling of the refractory and prolongs its life. 12 references. WHS (3a)

A Practical Device for Injecting Alloying Elements into Liquid Iron (Eine praktische Vorrichtung zum Einführen von Legierungselementen in flüssiges Eisen) *Giessereipraxis*, Vol. 59, Dec. 4, 1938, pp. 499-500. Practical. To attain a good mixture of metal and alloying constituents, a special type of ladle-like container is applied in which the tapped cupola Fe first flows against the curved backwall and then over the mold-like bottom and through the outlet channel. That this device guarantees a good mixture may not be doubted, but the wear on the refractory lining of the device must be considerable. GN (3a)

The Deoxidation of Basic Bessemer Steel with Basic Bessemer Pig Iron (Die Desoxydation des Thomasstahles mit Thomasroheisen) O. SCHEIBLICH. *Stahl u. Eisen*, Vol. 58, Nov. 10, 1938, pp. 1293-1295. Practical. A new practice, previously tried during the World War but later abandoned, is described. Using it, basic Bessemer pig Fe, kept molten in a small 2.5 ton ladle, is added to the basic Bessemer converter during the blow in order to reduce the consumption of the usual deoxidizers, particularly FeMn. The results of an 8-month run, during which about 150,000 tons of steel were made in this way, are stated to be successful. A 20% saving in FeMn was effected and the steel made was of good quality; it rolled well, showed practically no increase in P content over such steel made in the usual way, and gave good mechanical properties. SE (3a)

3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Modification of the Saeger Fluidity Test as Applied to Red Brass. GEORGE P. HALLIWELL (H. Kramer & Co.) *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Dec. 1938, pp. 374-384. A modification of the fluidity test, as developed by Saeger and Kryuitsky, has been used for the determination of the flowing power of brass. The method consists in permitting metal under a definite head to flow from the bottom of a preheated crucible into the fluidity spiral. Minor changes in basic composition appear to have no noticeable effect upon the fluidity. The presence of 0.5% Ni in all samples does not affect the fluidity within the series. For a red brass with a composition of approximately 85% Cu, 5% Sn, 5.3% Pb, 4% Zn, 0.5% Ni and 0.2% Fe, the fluidity is approximately a straight line relation between 1900° and 2200° F., with a length of spiral of 20 in. at 1950° F. and 40 in. at 2170° F. In this method of testing fluidity the personal equation involved in pouring has been reduced to a minimum, the sensitivity has been increased and the temperature drop from pouring crucible to spiral is probably less than in other methods. CMS (3b)

Progress in Aluminum Castings through Foundry Technique and Testing Methods (Fortschritte auf dem Aluminiumgussgebiet durch Giesstechnik und Prüfmethoden) J. DORNAUF. *Giesserei*, Vol. 25, Dec. 30, 1938, pp. 664-669. Practical. Some particularly instructive examples show the casting of complicated parts in Al and Al alloys by chill mold and combined sand and chill mold methods. Testing methods and their correct applications with respect to reliable results are discussed; values obtained from specimens cast on to the casting are more reliable than such obtained from separately cast specimens. X-ray testing generally reveals any large segregations or voids that may exist, but cannot be used for spongy spots, slag inclusions and segregations at the grain boundaries. Defects at the surface are reliably discovered by the milk of lime and oil test. In this test the specimen is first dipped in hot oil and then rubbed with sawdust. The dried surface is then treated with lime powder dissolved in alcohol. Fissures and small cracks show up very soon, as the oil marks them on the dried lime deposit. Heating improves this test. Ha (3b)

Melting Copper Base Alloys. N. K. B. PATCH. *Foundry*, Vol. 66, Sept. 1938, pp. 34, 74. Practical discussion. In melting Cu base alloys, in which a small per cent of Ni is desired, Cu and Ni are charged first. Ni should be charged in form of an alloy, 50% Ni and 50% Cu. By this procedure melting temperature is reduced, as well as gas absorption by the bath. After this, Sn, Pb and Zn are added. If no Zn is used, a deoxidizer should be added, such as P or Mn, in small percentage. Slag covering is not recommended because of the S absorption by melt and its bad effect on furnace lining. In melting red brass alloys, Cu is melted first and Zn used as deoxidizer. The value of P and Mn as deoxidizing agents is considered. VSP (3b)

Non-ferrous Foundry Practice. XIV. Copper and Straight Brasses. J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 53, Nov. 25, 1938, pp. 509-513. General. Cu castings are usually specified for duties demanding highest electrical conductivity. High grade electrolytic Cu is used. A deoxidizer is essential if sound castings are to be obtained. Because these affect the conductivity, the choice of the proper deoxidizer is important. If not otherwise disadvantageous, P is preferred. Zn, Si, Li and Be are available for this purpose. The Cu must be melted under charcoal and poured at 1200°-1250° C., and the deoxidizer stirred in just prior to pouring. Runner gates must be large. Neither bottom nor top pouring is recommended and a compromise must be effected. Owing to high solidification shrinkage, provision for adequate feeding is necessary. In brass foundry practice, because of rapid cooling, phases may be present in the alloy which, from its composition, should not theoretically be present. Because all the phases vary greatly in properties, alloys covering a wide range of quality are obtainable by ensuring the presence of only one phase or, alternatively, of a combination of 2 phases in the microstructure. α brasses (100-61 Cu) are soft and ductile, with maximum ductility at 70% Cu, 30% Zn. The inferior strength makes the α brasses less suitable for castings. They are very amenable to cold work, but cannot normally be worked hot. α-β (39% Zn or more) are harder, stronger and less ductile. They are more machinable than α brasses and very suitable for hot work. Because of their greater strength, they are preferred for castings. β brasses (53.5-50.5% Cu and 46.5-49.5% Zn) form an important section of the high strength casting alloys. β-γ brasses (53.5% Zn) containing γ in more than minute proportions are not commercially usable. As the amount of α constituent decreases the strength and hardness increase and the ductility drops off. Up to 1% Pb can be disregarded, but more than this progressively reduces both the strength and the ductility, but at the same time improves the machinability. For most castings, green sand molds can be employed; fine-grained sand must be used. Large thin-sectioned molds must be poured relatively hot, which increases the scabbing, and the sand should be worked on the dry side and freely vented. Crude oil on the mold face near the runner will help. Very thin castings require a dusting of powdered resin over the face of the mold. Small castings need little or no mold dressing, but a dusting of ground lime will facilitate stripping. The casting temperature for brass is by no means so critical as with the Sn-bronzes. Casting too hot causes high Zn losses, scabbing and higher liquid shrinkage, while casting too cold produces short runs, cold laps, trapped air bubbles, and drawing of the heavy sections. The most suitable casting temperature for general use is 1130°-1150° C. Brasses require a somewhat greater machining allowance than do Sn-bronzes. For small castings, 1/16 in. is suitable; for faces cast downward or vertically, 1/32 in. will suffice. For larger castings having an overall of 5-6 ins., 1/8 in. may be required on top faces and 1/16 to 3/32 in. on others. For large dry sand castings, a minimum of 1/8 in. may be necessary, and 3/32 or 1/4 in. on upper machined surfaces, if these must be cleaned. 9 references. For parts XII and XIII see *Metals and Alloys,* Vol. 10, Mar. 1939, p. MA 145 R 3 and R 6. RWB (3b)

Non-ferrous Foundry Practice. XV. The High Tensile Brasses. J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 53, Dec. 16, 1938, pp. 585-588. Practical. The addition, to 60:40 brasses, of various other metals results in a variety of improved casting and forging alloys, possessing high strength, good ductility and excellent resistance to corrosion. The metals used both alone and together, are Al, Fe, Mn, Ni and Sn. The approximate structural Zn-equivalents of these metals are: Al, 6; Sn, 2; Pb, 1; Fe, 0.9; Mn, 0.5; Ni, —1.3. Al increases strength and hardness, and reduces ductility; forging brasses should contain no Al. In casting brass, additions of Al alone should not exceed 2%. Fe causes the appearance of a third insoluble constituent and aids grain refinement, but has little influence on mechanical properties. Pb is an impurity and seldom an intentional addition in complex brasses. Quantities of 1% Pb or over reduce the strength, ductility and shock resistance. The influence of Pb is much more pronounced in forged or rolled material. Up to about 4% Mn causes increase in strength; the elongation shows maximum increase at 1% and reductions at 2½-4%. Mn increases Fe solubility, also the resistance to corrosion and erosion. Ni-brasses are classified as those within the range: Cu 45-55, Zn 35-45 and Ni 10 (max.) Ni-silvers contain some 10-30% Ni and much less Zn. To show any marked advantage at least 10% Ni is required. In smaller quantities (2%), Ni improves the miscibility of some of the other additions, and also increases the corrosion resistance. Sn is a hardening constituent in complex brasses, increasing the strength and hardness and reducing ductility. Sn solubility increases with Zn content. It is suggested that all the advantages of Sn may be obtained with Al, and that Sn should not be used in high tensile brasses. In forging brasses, Sn is undesirable and should not exceed 1% Sn and Al should not be used together; 1% Sn limits the Mn and Ni to low proportions. Al also restricts the quantity of Ni. 14 references. **XVI. Manganese Bronze.** *Ibid.,* Vol. 54, Jan. 6, 1939, pp. 7-10. Practical. Mn bronzes have, in general, the strength of mild steel combined with good ductility and high corrosion resistance. They are readily hot worked or cast, and are considerably stronger but somewhat less ductile than straight brasses containing similar proportions of Zn. Cast Mn-bronzes are either α plus β or full β brasses. The β brasses are much more resistant to cavitation erosion. In spite of their greater strength and hardness, β brasses are much more liable to fatigue or corrosion fatigue than those showing normal α plus β structure. Mn-bronze is much more difficult to cast than Sn-bronze, owing to the greater tendency to form dross and the very high solidification shrinkage. When the casting permits, slow pouring should be used. The in-gates should enter at the bottom of the mold, and when possible, should run directly under a riser. Solid shrinkage of Mn-bronze varies between 1/8 and 3/16 in. per foot. Chills are often essential and can be made of cast iron, mild or cast steel, Cu containing 1% Zn, Ni-bronze or even a good quality gunmetal; the last is not recommended for use directly in front of an in-gate, because there is danger of its fusing. Where ideal casting conditions can be maintained, there is no need for a machining allowance greater than for Sn-bronze. The pouring temperature has little effect on the density, but the liquid shrinkage is increased directly by hot pouring and thus Mn-bronze should be poured at as low a temperature as possible. A suitable casting range for most types of casting is 950°-1050° C. **XVII. Aluminum Bronze.** *Ibid.,* Jan. 20, 1939, pp. 107-110. The straight Cu-Al alloys, commonly called Al bronze, show considerable advantages over many other alloys for a number of duties and have come into increasing use in the recent years. Their resistance, both to fatigue and corrosion fatigue, is as good as Cu-Ni alloys. They resist sulphuric acid, have high thermal conductivity, and good heat resistance; the castings will withstand high hydraulic pressure. They have good mechanical properties, which can be improved by heat treatment. The formation of Al oxide, tendency to absorb gas, and pronounced piping cause these alloys to have poor casting properties. Cu-Al alloys have maximum ductility with about 4 Al; with increase in Al, the tensile strength increases and ductility falls; the most useful Al range is 7-10%. Normally cooled alloys up to about 9.5% Al consist of α solid solution; from 9.5 to 16.5% Al they consist of α and δ. The α phase is soft and ductile, while the δ phase is hard and brittle. The β phase (9.5-16.5% Al) cannot be retained at room temperature. Alloys within the β range and stable at high temperatures can be readily worked hot (550°-1000° C.), but not if the brittle δ is present. Castings may be improved by heat treatment. These processes are somewhat analogous to those used for steel. Alloys heated over 600° C. and slow-cooled may "self anneal." The β constituent is completely resolved into the α-δ eutectoid. By quenching and tempering, the β decomposition products show an acicular constituent, the so-called "striated β" of earlier observers. This acicular constituent is called β_1, the crystals of which are regularly oriented with respect to the original β, and is an unstable supersaturated solution of Al in Cu, which is produced by deformation of the lattice without diffusion. β_1 below 300° C. may be converted into β', which has a lattice similar to that of the α phase (β' is actually sometimes called α'). The decomposition of the disordered β phase takes place in 3 stages: $\beta \rightarrow \beta_1 \rightarrow \beta' (\alpha') \rightarrow (\alpha + \gamma)$. This transformation is reversible, and the phases cannot be retained by quenching. The β_1 and β' phases are unstable and slowly revert to α and δ at 350°-580° C. The stable $\alpha + \delta$ structure produced by annealing β_1 at 400°-500° C. is martensitic. Upon slow cooling of β, the $\alpha + \delta$ structure becomes eutectoidal. The rate of cooling has a considerable effect on the nature of the β-decomposition products. Slow cooling and self annealing occur in Al-bronze sand castings of heavy sections, which are characterized by a coarse structure and poor mechanical properties. This can be somewhat remedied by casting in warm Fe molds. Sand castings should be recovered from the mold as soon as solid. The self-annealing effect may be corrected by heat treatment. Alloys containing 3-4% Fe or Ni are not self-annealing. 13 references. RWB (3b)

A Copper Alloy with High Graphite Content (Eine hochgraphithaltige Kupferlegierung) *Automobiltech. Z.,* Vol. 41, Dec. 25, 1938, p. 644. Descriptive. The attempt to add graphite to bearing materials in order to improve the running properties has previously failed because the graphite segregates. Recently a method was found by which 20-25% of graphite can be distributed evenly through a Cu matrix, at least at the surface, to give a self-lubricating and wear-resisting material. Strength values are not available as yet; the impact resistance may be low. The alloy is melted in graphite crucibles by high-frequency current; the use of high-frequency, because of its stirring action, achieves thorough mixing and homogenizing. The molten metal is poured into cooled metal molds; there is no time for the graphite to segregate. Only small allowances for machining should be made, since the material is best near the surface. Diamond or high-speed steel is used for machining. RPS (3b)

4·WORKING

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER AND H. W. GRAHAM, SECTION EDITORS

New Applications for Press Work. Part III. The Deep Drawing and Pressing of New Alloys. J. D. JEVONS. *Metal Ind., London,* Vol. 53, Dec. 2, 1938, pp. 541-544; Dec. 9, 1938, pp. 565-569. Practical. Most deep drawing and pressing is confined to brass and steel. New varieties of metals rather than modifications in technique are discussed. The machining properties of ordinary α-brass are poor, and it is only recently that by application of special casting methods to ensure the dissemination of the Pb in a very fine state has it been possible to take advantage of the increase in ease and speed of machining due to 1-2% Pb in drawn and pressed brass. The advent of all metal aircraft construction has opened up a new field of application for thin-gage alloy steel. Alloy steel can be pressed into shapes of unexpected depth; no difficulty is experienced in producing a cupped diaphragm from alloy steel strip of 45 tons/in.^{2} tensile strength containing 0.15% C, 3.2% Ni, 1.0% Cr and small percentages of Mo and V. Recent developments make the deep drawing of stainless steel feasible. The essential difference between the austenitic alloys and the apparently more ductile metals such as low C steel and brasses is that the rate of work hardening of the stainless steel increases very rapidly at first and more power is needed to draw it. Modern furnaces have overcome the inter-stage annealing difficulties. Alloys, such as Armstrong metal (0.10% C, 4-6% Mn, 17.5% Cr, 8.0% Ni), may find a wide field of application for the production of deep drawn and pressed shapes. Considerable attention also is being paid to the use of low-C straight Cr stainless steels. "Deoxidized Cu" of good quality will withstand deeper draws than ordinary grades before inter-stage annealing becomes necessary. In addition to the familiar Cu alloys (Cu-Ni, Cu-Zn, Cu-Ni-Zn) Cu-Si, Cu-Al are finding application. The very satisfactory way in which Ni and its alloys behave under the press does not seem to be generally recognized. Cu-Ni (80% Cu, 20% Ni) has excellent deep drawing properties. At present the deep drawing of Ni silver is confined to "electroplate" ware. The use of Al and its alloys for deep drawing is developing rapidly. The present position of the Mg alloys from the economic aspect may be compared with that of Al some 40 years ago. As the price of Mg drops, the Mg alloys will certainly replace those of Al for many purposes. The behavior of Mg sheet under the press is poor. Owing to troublesome precautions required, no considerable extension in the application of Zn for deep drawing and pressing seems likely. There is little reason why the application of precipitation hardening alloys (dural, Be-Cu, Ni-Al, etc.) to this field is not feasible. Future developments seem likely to take place in 2 distinct directions, namely, in the more extensive use of coatings applied solely for the purpose of lessening the tendency of the base metal to foul the tools and, secondly, in methods for more severely deep-drawing and pressing of clad sheet. In addition to their recognized protective power against corrosion, Cu, Sn, Cd and Pb offer benefits as a lubricant for steel sheet intended for deep drawing. The drawing of plated material is done but is not successful, except with ductile coatings. For Part II see *Metals and Alloys,* Vol. 10, Mar. 1939, p. MA 146 L/3. RWB (D-4)

Jobbing Die Steels. NORMAN I. STOTZ (Universal-Cyclops Steel Corp.) *Iron Age,* Vol. 142, Dec. 15, 1938, pp. 42-44. Practical. The disadvantages of oil-hardening die steels and high C, high Cr types are considered, and data given on a new tool steel known as Sparta, developed by Universal-Cyclops Steel Corp. for Westinghouse Elec. & Mfg. Co. This new steel offers die economies of from 40 to 60% over other die steels. Chemically, this new air-hardening die steel depends on Cr of from 5 to 6% balanced with C and V, plus enough Mo or W, or both, to render it hard when quenched in still air. A table is included giving Rockwell "C" hardnesses after various heat treatments of Sparta die steel. Hardening temperature is not higher than that for high C, high Cr types. It is 300° F. higher than ranges used for Mn oil-hardening type. Tempering heats are very low. It may be also used for master gages, shear blades, punches, etc. VSP (D-4)

Developments in Extrusion. Improvements in Press Design. E. PFANN. *Metal Ind., London,* Vol. 54, Jan. 6, 1939, pp. 13-15. Historical. Since its invention 45 years ago, the hydraulic extrusion press has become one of the most important machines in the non-ferrous industry. At the beginning of the century the press was improved, permitting the extrusion of rods from solid billets. The power of the presses of this period ranged from 500 to 1,000 tons. With the development of design, combining a hydraulic piercing ram to produce tubes, the power was increased to 1,000-2,000 tons. Recently, the power has been increased to 5,000 tons. The 5,000-ton press differs considerably in its appearance from the earlier and smaller presses. Light alloys are extruded very slowly. The container works at a temperature approximately the same as the billet. This is obtained by use of a built-in thermostatically controlled induction heating system. The main cylinder of a 5,000 ton press weighs over 65 tons, and is water tight under internal working pressures of some 300 atmospheres. The complete press, without any accessories, weighs about 350 tons, having an overall length of 130 feet. RWB (D-4)

Machinability Testing by Measuring Cutting Temperature and Tool Wear (Zerspanbarkeitsprüfung durch Messverfahren für Schnittemperatur und Werkzeugverschleiss) HEINRICH SCHALLBROCH, HANS SCHAUMANN & REINHARD WALLICHS. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde,* 1938, pp. 34-38. Research. New methods have been devised in recent years for investigating machinability of metals, based on measurements of cutting temperatures and tool wear. For certain materials that fail easily by temperature effects, the relation between stand-up time T and temperature t endured by the tool material was investigated. This T—t relation is a definite characteristic for a certain high speed steel independent of cutting conditions, and could be correlated to the t-v relation (where v is cutting speed), so that the coordinated values of T and v for various types of high speed steel and various materials to be turned under different conditions can be determined. Furthermore, extensive tests on effect of wear on the tool gave new knowledge on relation between tool wear and cutting time, machinability, cutting pressure (energy consumption), surface condition and stand-up time. GN (G-4)

Behavior of Steels and Light Metals during Drop Forging (Das Verhalten von Stählen und Leichtmetallen beim Gesenkschmieden) K. DAEVES & A. RISTOW. *Stahl u. Eisen,* Vol. 58, Dec. 22, 1938, pp. 1451-1457. Original research. A series of forging tests were made in which various C and alloy steels and light Al alloys were drop-forged at various temperatures into a die that gave a sample having a shape like a top with a flat disk at the equator and stepped cones extending to each pole. The approach to completeness with which the die was filled out, especially the extremes of the thinnest cones, was observed. Heat-resisting Al steels with about 4% Al and similar Al-Cr and Cr ferritic steels filled out the dies especially well on heating to 1050° C.—better than plain C open-hearth structural steels did. An austenitic steel with 23% Cr and 20% Ni showed the poorest filling-out properties. A high P steel with 0.03% C and 0.25% P showed good hot deformability. The Al alloys were forged at temperatures up to 500° C. The age-hardening duralumin alloys gave much lower deformability than pure Al and a Cu-free Al-Mg-Si alloy containing 0.95 Si, 0.77 Mg and 0.95% Mn. SE (D-4)

Effect of Cutting Speed on Tool Life. *Machinery, London,* Vol. 53, Dec. 1, 1938, p. 262. Practical. Comparison of wear and cratering (rake loss) of tantalum carbide and high speed steel tools. With tantalum carbide, wear decreases from 0.025 in. at 50 ft./min. to 0.0125 in. at 100 ft./min., while with high speed steel it increases from 0.004 in. at 50 ft./min. to 0.015 in. at 100 ft./min. At 50 ft./min., the carbide is inferior to high speed steel; at 60 ft./min., the cratering is equal; at 97 ft./min., the wear is equal; at 110 ft./min. the high speed steel reaches the limit of its cutting ability; while the carbide is good up to approximately 200 ft./min. JZB (G-4)

4a. Ferrous

Character and Machine Performance of Lead-bearing Steels. FREDERIC J. ROBBINS (Bliss & Laughlin Co.) *Iron Age,* Vol. 142, Nov. 17, 1938, pp. 28-33. General review. Compares properties of usual Bessemer and open-hearth steels, and claims that they are not very satisfactory for "screw stock." Attempts have been made to improve open-hearth steel by the addition of Pb. An emulsion of Pb is produced in molten steel which when solidified leaves Pb in finely divided form throughout the ingot. There is a slight decrease in the McQuaid-Ehn grain size of Pb-treated steels, but the grain refinement seems to have no detrimental effect on machinability and heat treatment. Pb addition does not alter the physical properties of any of the S.A.E. steels so far studied, although case hardening ability is often decreased. In general, the leaded steels exhibit the same general physical and metallurgical characteristics as comparable analyses without Pb, and can therefore be specified for parts formerly made of such grades without the lead. Numerous cases are mentioned where substitution of leaded steels resulted in improvement in tool life, production efficiency, and part quality. VSP (G-4a)

Rail Corrugations. WALTER HOBSON. *Metals and Alloys,* Vol. 9, Dec. 1938, pp. 340-342. Practical review. It is suggested that corrugations and periodic hardness on the surface of rail heads originate in the rolling mill. Wobbler wear in the mill makes the rolling of the rail head jerky; the metal is not in the same condition of working when the roll is under varying torque as when the torque is smooth, so that the subsequent wear under the wheels of the train produces a slight corrugation of the surface. In steam railroad operation, where the driving wheels of the train were large in diameter, rail corrugation was not so pronounced as that of the electrically operated systems where the driving wheels were smaller in diameter. The theory may be tested by checking comparative rail heads in parallel service, one having been rolled in a mill having a 3-prong and the other in a mill having a 4-prong wobbler set-up. CWH (E-4a)

Changes in Ingot Structure of Steels by Forging at High Temperature. S. NISHIGORI, T. IWAKI & Y. HAYASI. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Nov. 1938, pp. 568-578. In Japanese. Original research. The structures of a 250-kg. ingot of C steel and Ni-Cr steel were examined. Increase of forging ratio, results in either intensification of dendrites or formation of fibrous structure depending on the forging section. Dendritic structure appears more readily in Ni-Cr steel than in C steel. For fibrous structure, Ni-Cr steel requires greater forging ratio than C steel. The fibrous structure is obtained, not by breakdown of columnar structure by forging, but by forging dendritic crystals in various directions. The dendritic structure becomes obscure in ingots forged after heating at high temperature. NS (D-4a)

4b. Non-Ferrous

New Applications for Press Work. IV. New Processes for Shaping Sheet Metal. J. D. JEVONS. *Metal Ind., London,* Vol. 53, Dec. 23, 1938, pp. 615-619. Review. A little-used procedure, which is not affected by the type of press employed, is that of warm pressing or drawing. This is seldom used except as a temporary shop dodge. With present data it is unsafe to conjecture in what way warm pressing benefits arise, but it seems likely that the important change is associated with work hardening effects rather than with modification of any of the commonly measured tensile properties. A shaping process for light alloy sheet, known as stretching, differs from pressing in that the outer regions of the sheet are not allowed to flow, even under the restrictive action of a pressure plate. Physical properties needed to ensure good behavior during stretching are not necessarily the same as those needed for deep drawing or pressing. Sheets of greater hardness and larger grain size can be used. Impact extrusion causes the metal to flow up the side of the punch, with the result that a deep thin-walled shell is formed in a single operation, whereas a considerable number of draws and probably several interstage annealing treatments would be needed to produce the same shell by ordinary methods of deep-drawing. This method permits the production of many shapes that cannot be produced by the ordinary deep-drawing methods. Increasing attention is being paid to the impact extrusion of metals other than the apparently ductile Pb, Sn and Zn. α brasses are now being impact extruded cold. Deeper shells may be produced by warming to relatively low temperatures. To obtain the deepest shapes it is essential that the majority of the metals be in the purest possible state: Cu at least 99.9%; Al, unless purposely alloyed, of similar purity; Zn should be 99.99%; and α brasses of 70-75 Cu with minimum impurities. It is likely that one of the essential factors in impact-extrusion is the high speed of deformation. Also, the increase in temperature of the flowing metal greatly facilitates the desired flow. Impact-extrusion presses must be very sturdy. Vaseline is a good lubricant. This indicates that the properties required of a deep drawing lubricant may not be the same as those required for impact-extrusion. For Part III see p. MA 270L/3. RWB (D-4b)

a.c.f. Air-Operated

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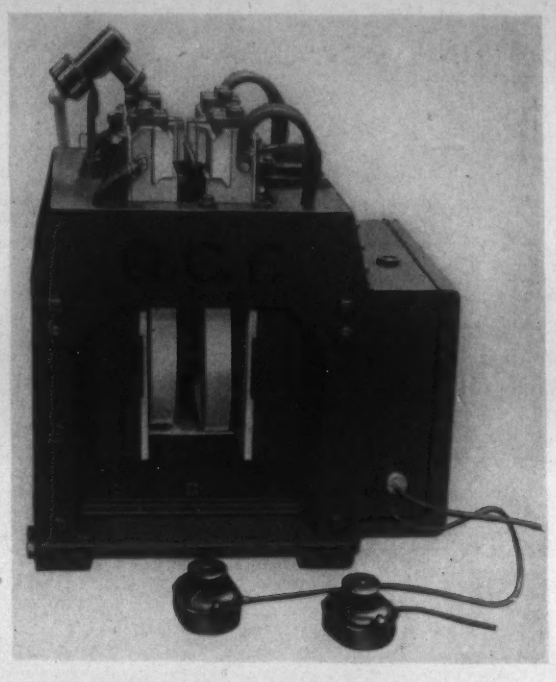
a.c.f. BERWICK ELECTRIC NO. 3 TYPE "L" HEATER, equipped with Electric Eye for controlling temperature; heats any diameter from 1/8 to 1"; any length heat from 1" up; water-cooled electrodes. Gives an end heat or a heat at any point on the bar.



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Hot Pressing and Machine Forging. J. H. FRIEDMAN (Natl. Machinery Co.) *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 47-50. Developments in methods and equipment. Recently rapid strides have been made in the field of hot pressing of non-ferrous metals. The advances have been made not because of research and development in the non-ferrous metal-producing field but because of demand created in the automotive field. The modern coining press was the result. The "spring" has been reduced to the vanishing point, die alignment is extremely accurate, ejection is quick and positive and production is greatly increased. Experience has proved that machine rigidity has a major effect upon metal flow. Forging in a weak bed frame results in an excessive amount of flash and, at the same time, in an improperly filled forging. There is considerable evidence to indicate that satisfactory results are obtained only so long as there is no appreciable reduction in working velocity. Evidently, once the metal starts to move, no trouble occurs if it is kept in rapid motion, but should the operation pause for any reason, it is generally found impossible to cause it to start to flow again. Most specifically, there is a great amount of evidence to prove the desirability of stiffness in equipment of this type, and none to disprove it. Almost as important a factor is speed. Convenience and ease of feeding, quick starting and positive and rapid ejection are all vitally important factors in ultimate speed, and have their effect on both output and die life. A good forging press must embody all the above features and the power of the die should be ample and positive; it should have instantaneous starting and it should be provided with rugged, accurately timed and quick acting knockouts. Owing to the fact that the temperatures on non-ferrous metals are much lower than for steel, the most modern presses leave nothing to be desired for handling non-ferrous metals. There is probably no factor in non-ferrous forging that is more important than the matter of heating. No hard and fast rule can be established for forging temperatures. They can be arrived at only after all the contributing factors of each specific job are known and considered. Non-ferrous hot forging has arrived. With modern presses, satisfactory die steels and a wide variety of forgeable non-ferrous alloys now available, even greater strides in this field may be expected in the immediate future. RWB (D-4b)

5·HEAT TREATMENT AND HEATING

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.

O. E. HARDER, SECTION EDITOR

Sillimanite as a Refractory for Electric Furnace Roofs. *Iron Steel Ind.,* Vol. 12, Dec. 1938, pp. 205-207. Discussion. Actual operating conditions show sillimanite as the best possible refractory for roof linings. Initial cost is much higher than for the average roof but it gives a much longer life. It is composed of SiO_2—37-39% and Al_2O_3—55-60%, plus iron oxide—1.0%, titania—1.5%, and total alkalis—1-1.1%. The user should be careful of substitutes, as many bricks are doped with a proportionate amount of Al_2O_3 and are not satisfactory. True sillimanite is mined as such in Central India. Specific gravity is not important but porosity is, since it governs gas permeability, erosion, corrosion and slag attack, the denser bricks being most suitable. It has a very low performance expansion, and thus bricks do not spall when either heated or cooled rapidly, and no expansion strips are needed when making up the roof. Sillimanite bricks withstand 60 or more alternate heatings to 1000° C. and quenchings in cold water, as a test for spalling, while average firebrick or silica brick last only through some 4-8 cycles. Design of roof bricks for neat fitting pattern over roof surface is important, and specially formed units should be used rather than chipping individual bricks to fit. Loose joints and excess dropping of brick result from the latter method. HFT (5)

Furnace Insulation. G. E. GRIMSHAW (Johns-Manville Corp.) *Ind. Gas,* Vol. 17, Feb. 1939, pp. 11-16. Practical. The various insulations available for gas-heated furnaces at from 400° to 2000° F. are discussed exhaustively. Advantages of fireclay brick over insulating fire brick are: Mechanical strength, spall resistance, abrasion resistance and high heat storage to maintain constant temperatures in batch furnaces. Walls and arches of fire clay brick, backed up with the proper amount and kind of insulating material, are used with advantage in continuous furnaces where time used in heating or cooling is of secondary importance; such construction is also employed in furnaces where the refractories are subject to mechanical abrasion and to severe thermal shock. Insulating fire brick are generally an advantage in periodic or batch type furnaces, or in furnaces with short operating cycles, and in bell type and portable furnaces where weight is important. The points for selecting a definite type of refractory are discussed in detail as to economy in operation, labor and space occupied. A table compiles 11 different types of refractories and insulation for wall construction with their heat-transmitting properties. Ha (5)

Insulation of the Arches of Open-hearth Furnaces (Isolation des Voûtes de Fours Siemens-Martin) J. ROBITSCHEK & F. SINGER. *Rev. Universelle Mines,* Vol. 15, Jan. 1939, pp. 21-29. Survey. The American practice of applying thermal insulation to the roofs of open-hearth furnaces is described; the heat transfer with different refractory materials is discussed at length and the paths of isotherms in the silica bricks determined. A list is given of refractory bricks made in U.S.A., Russia, Germany, England, Czechoslovakia and Belgium, showing Al_2O_3 content, weight per in.^{3}, heat conductivity, useful temperatures (max. 1450° C.) and compressive resistance. 27 references. Ha (5)

Lining for Reservoirs and Ladles Suitable for Soda Ash Treatment. J. J. OFFUTT (A. P. Green Fire Brick Co.) *Am. Refractories Inst.,* Bulletin No. 71, Aug. 1938. Original research. Soda ash, when used as a desulphurizer in reservoirs or ladles containing molten cast Fe, causes rapid destruction of refractories used in lining the container. Limitations of plastic refractories, rammed ganister, high-alumina and first quality stiff-mud refractories are pointed out. A special brick with a pyrometric cone equivalent of 33-34 (3173-3200), a porosity of 12-13%, and advanced mineral development due to being fired at higher temperatures was found most satisfactory. Attack at the joints between brick was found greater with air-setting mortars containing sodium silicate than with heat setting fire clay base mortar. RAW (5)

The Use of the Refractory Metals Molybdenum and Tungsten in High Temperature Electric Furnaces (Emploi des Métaux Réfractaires, Molybdène et Tungstène, dans les Fours Électriques à Haute Température) JEAN MICHEL. *Chimie & Industrie,* Vol. 40, Dec. 1938, pp. 1060-1065. Original research of practical value. Graphite resistors allow a very high temperature but are too fragile, easily attacked by O_2, and tend to carburize the work in the furnace; also the electrical resistance drops with rising temperature, which makes control difficult. Pt, being very costly, is used only as fine filaments extremely sensitive to slight changes. With "silit" bars (silicon carbide), 1450° C. is about the limit for constant operation; above this temperature frequent replacement is necessary. With Mo and W, because of their exceptional mechanical properties at high temperatures, strong furnaces can be built that operate at 1800°-1900° C. The customary method of supporting the resistor on refractory has major disadvantages: Refractory is subject to the highest heat in the furnace because it is in direct contact with the resistor; in addition, all refractory materials attack the metal more or less strongly. With this design, slow heating cycles are required so as not to crack the refractory. W is also used as bars or tubes made from powder. Furnaces with such heating elements generate up to 3000° C., but draw exceedingly high current. Mo and W are very susceptible to O_2 attack at high temperature. When using vacuum, practical difficulties arise because traces of O_2 are harmful, and volatilization of the metals occurs. The use of an inert gas requires very careful purification. H_2 is more efficient under slight positive pressure and, even without unusual scrubbing, preserves the heating element in perfect condition. Purging by previous evacuation is recommended. Because the gas flow in the furnace cools the charge, reduction of the amount of porous refractories present is required. A furnace is described, built according to the requirements and principles outlined. The Mo resistor is a ribbon bent to a coil without support. The connections are made from cooled Cu. The coil is strong enough to hold small boats or crucibles, although the latter may be supported outside the coil so as not to touch it at all. Obviously quick heating and temperature changes can be affected, approaching those obtained in high-frequency units. W bar or tube resistor furnaces have similar properties; however, the electrical resistance is low, which makes the current high and the installation complicated. Elongation of the elements has to be allowed for. Construction and characteristics of Mo and W resistor furnaces are described. RPS (5)

New Developments in High-frequency Furnaces (Nyare utvecklingslinjer foer hoegfrekvensugnar) L. DREYFUS. *Tek. Tid.,* Vol. 69, Jan. 14, 1939, (Section *Bergsvetenskap*) pp. 1-4. Review. The question of building large high-frequency furnaces with basic lining has long proved very difficult. Acid furnaces with a capacity of 6-8 tons, which will smelt 400 or more charges before the crucible has to be replaced, are used. However, it has been found difficult to find material for basic crucibles over a capacity of about 2 tons. Recently these difficulties seem to have been solved and a basic material has been developed in Sweden that may be used in furnaces up to 4 or 5 tons capacity. Another recent development is the use of small high frequency furnaces for working and heat treatment of tool steel and drill steel. The most important feature of these furnaces is that it is possible to confine the heating to a small part of the tool only by using a lamellar magnetic circuit adapted to the shape of the tool. BHS (5)

Refractory Materials for Blast Furnaces (Les Produits Réfractaires pour Hauts Fourneaux) A. CLAUSSET. *Rev. Universelle Mines,* Vol. 15, Jan. 1939, pp. 29-32. Research. The destruction of the refractory lining of blast furnaces is studied as to its causes in the different levels of the furnace; the principal points to be considered are mechanical resistance to impact and abrasion, thermal resistance, chemical resistance, and resistance to CO. The reactions between the constituents of the charge, metal, coke and slag are explained and a curve is given for the melting temperature of the system Al_2O_3-SiO_2 to facilitate the proper selection of refractory for each zone in the furnace. Ha (5)

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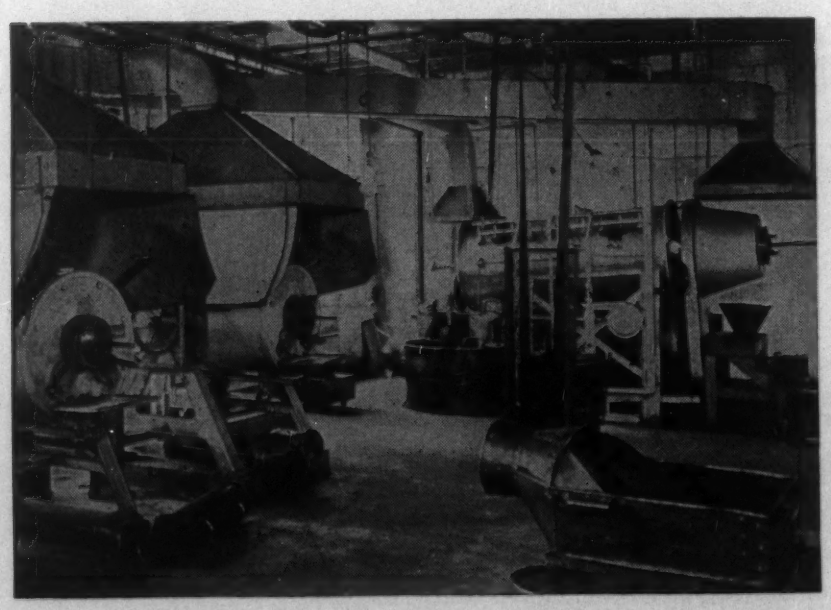

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Effect of Firing Temperature and Grain Size on the Permeability of Refractory Brick (Einfluss von Brenntemperatur und Korngrösse auf die Gasdurchlässigkeit feuerfester Steine) A. KANZ. *Arch. Eisenhüttenw.*, Vol. 12, Nov. 1938, pp. 247-251. Original research. Permeability tests of various refractories, particularly fireclay, gave the following results: Higher firing temperatures increased the permeability, especially between 900° and 1200° C., until sintering occurred. This was irrespective of grain size. Sintering decidedly decreased the permeability. The permeability increased greatly, the larger the grain size, this effect being much larger and independent of the effect of firing temperature. Differences in permeability between refractories of the same composition are mainly due to differences in grain size. Desired permeabilities can be obtained by properly blending materials of different grain size. Permeability tests offer a convenient means of determining the uniformity of refractories and their probable resistance to such service conditions as Zn vapors, for example. SE (5)

Clarkdale Method of Hot-patching Operating Furnaces. C. R. KUZELL (Phelps Dodge Corp.) *Metals Tech.*, Vol. 6, Jan. 1939, T.P. 995, 12 pp. Practical. A method was developed for patching furnaces by spraying an emulsion of fine refractory material in water into a hot furnace. This has been used for Cu smelting furnaces but is claimed to be applicable to other furnaces. The refractory material must be very fine, all through 200 mesh, and should be mixed with an equal weight of water. The nature of the refractory material depends on the nature of the material to be patched and the nature of the environment. In the Cu furnaces, the material to be patched is silica brick. A material that was principally silica and a binder was used. In patching, it is important that the spray be not too violent and that not too thick a layer be applied at once. JLG (5)

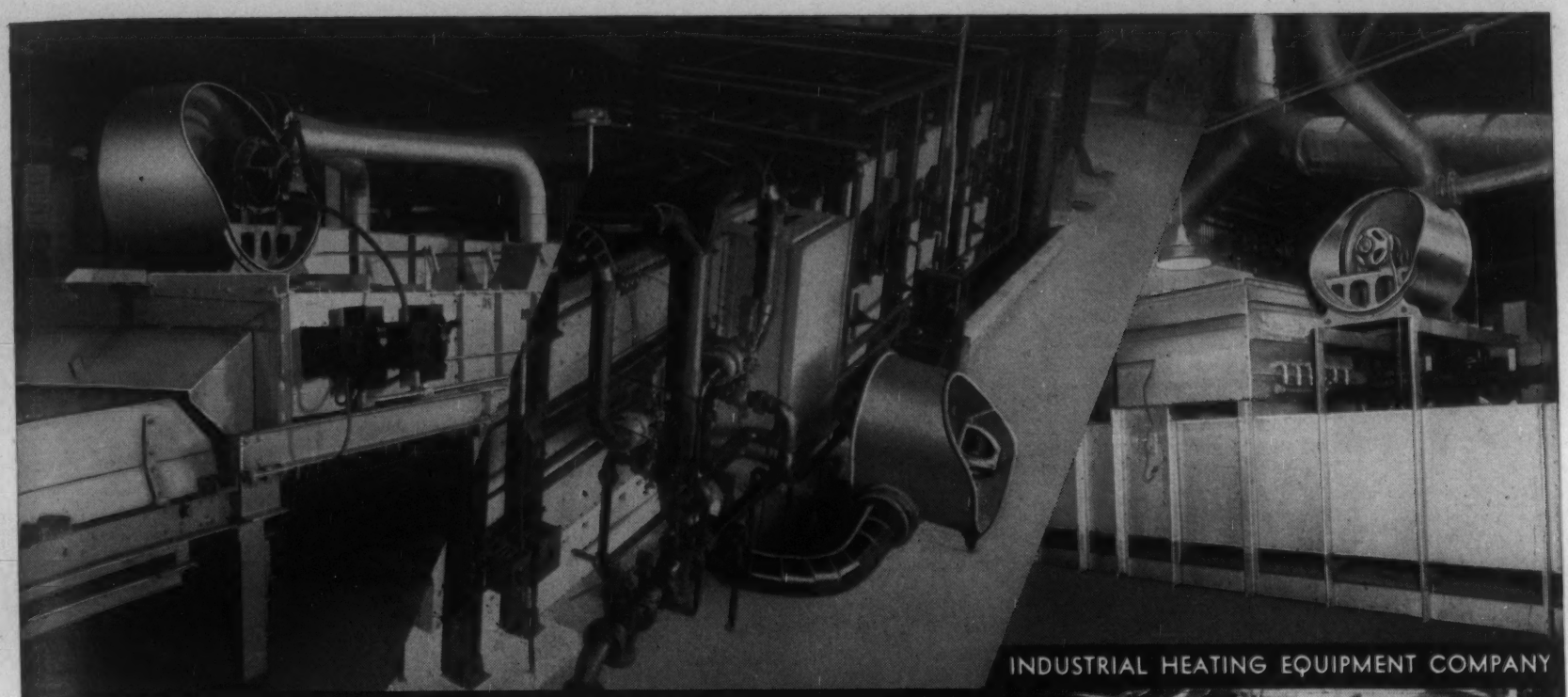
5a. Ferrous

O. E. HARDER, SECTION EDITOR

Gas Carburizing with Pure Propane. FRED P. PETERS (Staff) & M. G. FARRAR (Carbide & Carbon Chem. Corp.) *Metals and Alloys*, Vol. 10, Jan. 1939, pp. 13-17. Practical. The background of carburizing with propane gas is discussed, and the practice and experience of a typical user of "Pyrofax" gas carburizing —the Frick Co., Waynesboro, Pa.—are described. City gas is generally unsuitable as a carburizing medium because of its non-uniformity and often high moisture content; natural gas is a good carburizing medium, although there are some areas where the available supply is not suitable; pure propane, because of its particular chemical nature and uniformity, is an ideal gas for carburizing purposes. Excellent, controllable case properties and absolute case uniformity are obtained with propane; also, such a bottled gas can be used for carburizing where no piped gas is available. The Frick Co. uses Pyrofax gas for carburizing piston pins, ranging in diameter from ½ in. to 5 in., in a vertical AGF carburizer. Carburizing of each batch (up to 320 lbs.) is complete after 6 hrs. at 1670° F.; the work is then furnace-cooled, reheated to 1450° F., and water-quenched. The case thus produced is 0.060 in. deep, with Rockwell C 62-65 after hardening. The consumption of Pyrofax gas is about 2 lbs./hr. Frick Co. estimates an overall cost of $0.04/lb. of work with Pyrofax gas, as compared with $0.13/lb. with their former method—pack hardening. Complete description of the installation, and a month's operating log are given. FPP (5a)

Factors Influencing Annealing Malleable Iron. A. L. BOEGEHOLD (General Motors Corp.) *Trans. Am. Foundrymen's Assoc.*, Vol. 46, Dec. 1938, pp. 449-482. Research. Experiments are described in connection with the determination of the shortest practical annealing cycle for 2 production castings representing the largest and smallest casting in current production at the time experiments were made. The iron studied differs somewhat in composition and method of manufacture from much of the malleable iron produced in this country. Steel scrap, silvery pig iron and foundry returns are melted in a cupola, producing an iron containing 2.70-2.75% C; 1.15-1.20% Si; 0.38-0.42% Mn; about 0.05% P; and 0.09-0.11% S. This iron is transferred to a direct arc electric furnace, heated to casting temperature and 3 to 4% steel scrap added. The net result of the work described is that the preferred annealing cycle for the Fe in question is as follows: Heat to 1500° F. at a convenient rate, heat from 1500° to 1700° or 1725° F. at 36° per hr., hold at 1700-1725° F. for 8 hrs., cool to 1400° F. at 150° per hr., cool from 1400 to below 1310° F. at 7° per hr. CEJ (5a)

Definitions on the Heat Treatment of Steel (Begriffsbestimmungen für die Stahlbehandlung) K. DAEVES. *Stahl u. Eisen*, Vol. 58, Dec. 1, 1938, pp. 1369-1370. 17 terms used in heat treatment are defined for the Vereins Deutscher Eisenhüttenleute. SE (5a)



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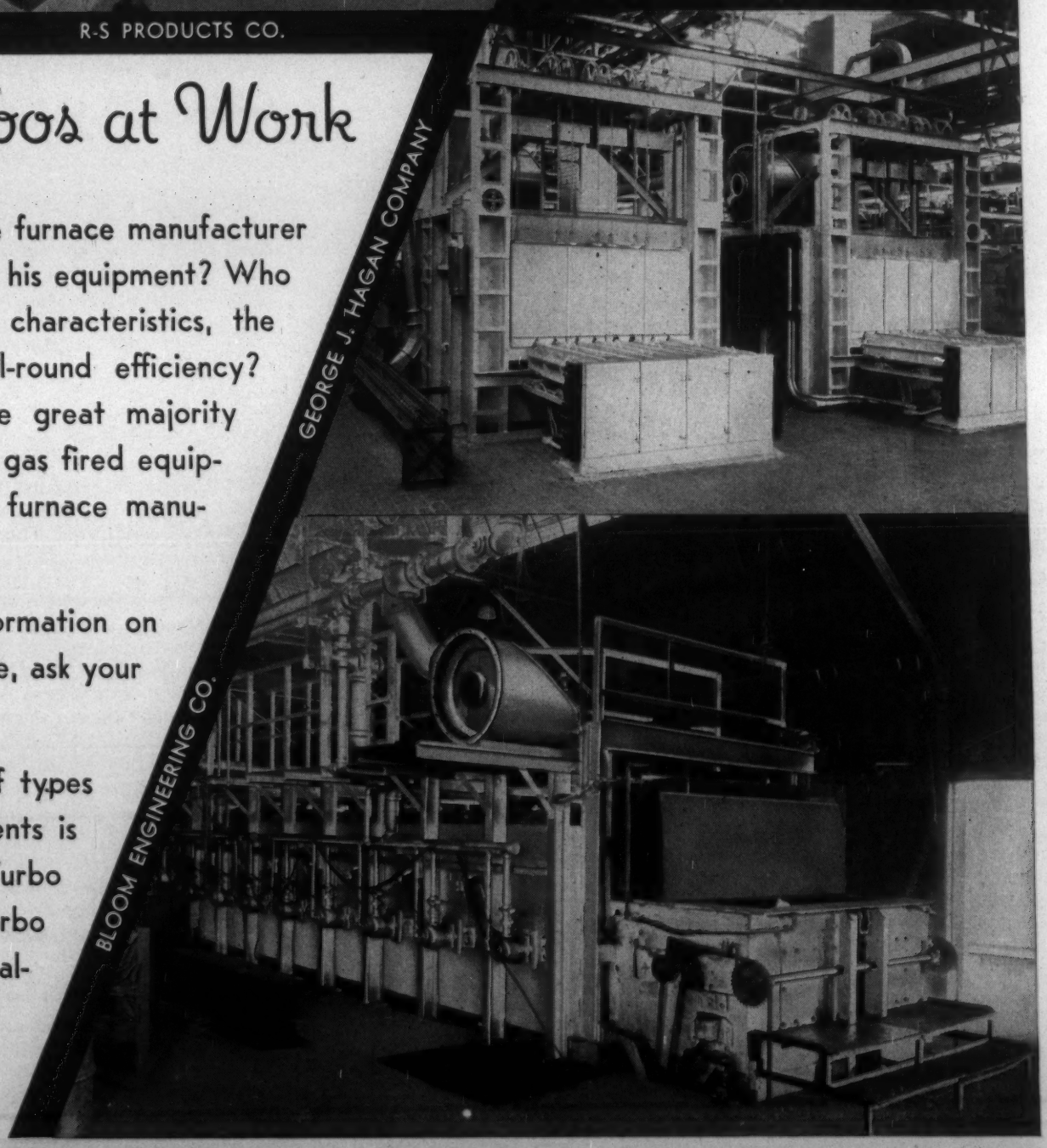

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Some Notes on the Malleablisation of White Iron. MAURICE LEROYER. *Foundry Trade J.*, Vol. 60, Jan. 5, 1939, pp. 6-8. Review plus original research. Two phenomena occur when making malleable from white iron: (1) Graphitization, which is the outstanding factor in the manufacture of black-heart malleable, and (2) decarburization, which is the basis of the production of white-heart (European). In practice, these 2 phenomena nearly always take place coincidently in the malleablization of iron. The methods available to the metallurgical engineer for utilizing the relative importance of the role played by graphitization or decarburization during annealing, and from these factors modifying the structure and properties of the final product, are set forth. Graphitization can be speeded (1) by increasing the annealing temperature, (2) by increasing the C content (increasing the number of nodules formed), (3) by increasing the Si content, (4) by the complete neutralization of the antigraphitizing influence of S through combining it with a suitable Mn content, (5) by working in a slightly oxidizing atmosphere in order to utilize the catalytic action of CO_2. Phosphorus, within the correct limits to avoid all separation of the brittle phosphide during annealing, has no profound influence on graphitization. The decarburization of the Fe takes place through the combustion of C by oxygen and carbon dioxide gases surrounding the castings. Decarburization can be promoted by lowering Si, the presence of an excess of S, elevating the annealing temperature and increasing the "strength" of the packing medium. The advantages of casting with a slightly increased C content in the Fe without lowering the mechanical properties of the black-heart castings can be obtained by intensifying, within limits, the decarburizing process. The danger of incomplete dissolution of the solidification carbides in the core of thick-sectioned castings in white-heart can be avoided by maintaining Si content high enough to set up graphitization in the core during the soaking period. The C so dissolved at the end of this period thus gives, on cooling, a high-strength pearlitic matrix, easily machinable and of good resilience. AIK (5a)

Handling Solid Carburizer in Continuous Box Carburizing. H. R. WEBER (Cadillac Motor Car Co.) *Metals and Alloys*, Vol. 9, Oct. 1938, pp. 255-257. Practical. A No. 2 size (½ in. diameter) commercial carburizing compound of charcoal base, containing 25% maximum coke, 10% barium carbonate, and 5% calcium carbonate, is automatically fed from a hopper, by gravity, into cylindrical heat-resisting alloy carburizing pots. Transmission and rear axle gears are packed in these containers. The carburizing furnace is a gas-fired continuous pusher type having 4 tracks. With a carburizing temperature of 1675° F., a total furnace time of 11 hrs. is required to obtain a case depth of 0.040 in. The pushes are made every 44 minutes per track and are staggered 11 minutes apart to facilitate manual operations on the unit as a whole. All handling of material and boxes is done by conveyors and air hoists. The carburized parts are quenched directly from the boxes. The carburizing boxes with the hot compound cool from 1500° F. to 1100° F. after traveling over a 90 ft. gravity conveyor at the end of which they are dumped, by air pressure, into a hopper that conducts the hot compound into a slowly revolving water cooled drum (detailed drawing included). This system is capable of cooling 1800 lbs. of compound from 1100° F. to 175° F. in 1 hr. The cold compound from the cooling drum is conducted to a dust separator where the fines harmful to good carburizing are removed. The remaining compound is passed over a magnetic separator to remove all metal particles and is then conducted back to the storage bins for further use. Manual labor and handling time have been cut to a minimum while savings in compound costs and scrap losses have more than paid for this installation. CWH (5a)

Effect of Annealing on the Hardness of Ledeburitic Chromium Steels (Einfluss des Glühens auf die Härte von ledeburitischen Chromstählen) H. GROSS. *Arch. Eisenhüttenw.*, Vol. 12, Jan. 1939, pp. 341-344. Practical. Cast steels of the general type 2% C, 12% Cr were studied in the microscope and with a dilatometer. The retained austenite from the as-cast state could be transformed by annealing either to pearlite or martensite. During long annealing, carbides precipitated from the austenite so that the austenite would not harden on cooling and pearlite would form instead of martensite. The amount of precipitated carbide depended on the time and temperature of annealing. Holding up to 24 hrs. at 870° C. gave martensite + troostite on slow cooling with 532 Brinell hardness. Holding at 740° C. for 1 hr. gave pearlite with 286 Brinell; holding at 740° C. 24 hrs. and slow cooling gave 223 Brinell. Additions of W up to 1.6% increased the rate of precipitation of carbides but, nevertheless, also increased the hardness after annealing. Additions of 2.2% Ni and 8% Mn also increased the hardness after annealing but this was because the austenite became more stable so that only martensite and not troostite or pearlite would form after annealing. However, the martensite could be softened somewhat by tempering below A_1, after annealing. SE (5a)

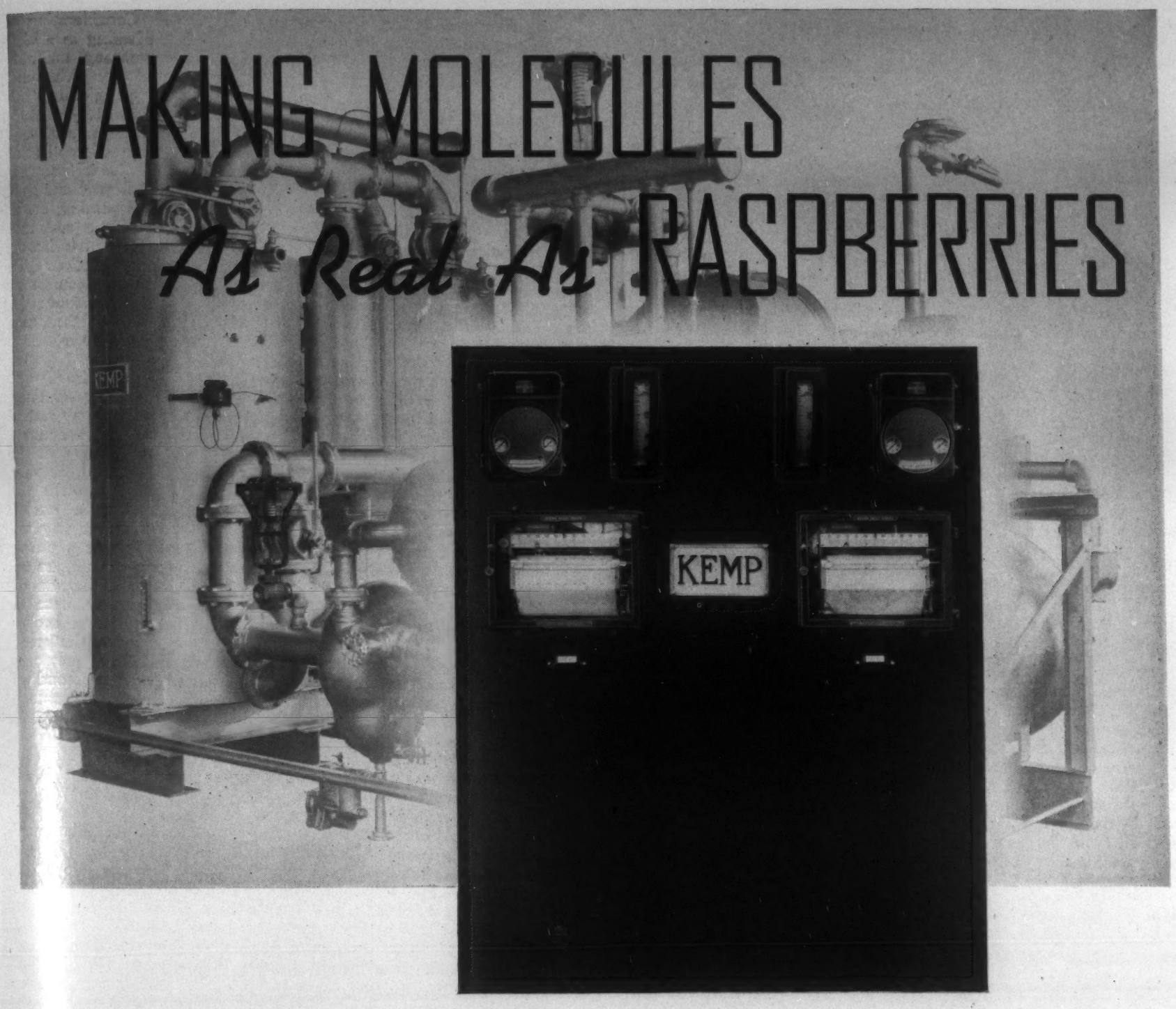
The Influence of Annealing Temperature and Time on Steel, Particularly Steel Sheet (Der Einfluss der Glühtemperaturen und-zeiten auf Stahl, insbesondere Stahlblech) R. POHL. *Metallwirtschaft*, Vol. 17, Nov. 25, 1938, pp. 1253-1256. Discussion. In Germany, steel in every form is a valuable material and its waste is to be avoided. Careful heat treatment is necessary to insure a minimum of scrap when deep drawing. For drawing, a fine grain size and low yield strength uniform in all directions, good ductility and low hardness are desired. If all these factors are obtained, then the stresses necessary for drawing are low. For drawing steels a degree of deformation of less than 7% and more than 30% results in no grain growth when annealing at 690°-780° F. The critical degree of deformation is about 9% and results in grain growth at the annealing temperatures. From a comparison of tensile tests and metallographic examination, it is apparent that the mechanical properties are to a large extent dependent upon microstructure. Here not only grain size but form and distribution of secondary constituents are of importance. Drawn objects are subjected to 2 draws before being given an intermediate anneal at 650°-850° C. The object of the second draw is to insure sufficient cold work so that the grain will not coarsen on annealing. A relation between the many single drawing factors has not been determined, so that the degree of deformation in drawing cannot be accurately determined. GA (5a)

Temper Hardening of Steel and a Theory of Tempering. S. A. MAIN. *Metal Treatment*, Vol. 4, Winter 1938-9, pp. 158-164. The theory that the hardness of quenched and tempered steel is connected with the degree of dispersion of precipitated carbides is rejected, because it is unable to explain why steels sometimes first soften and then harden again during tempering, or why the density should change about 1%. As an alternative theory, it is suggested that the hardness depends only on the relative amounts of retained austenite (Vickers hardness 200), martensite (Vickers hardness 900) and "transformed martensite" (Vickers hardness 200) that are present. On tempering a quenched steel, transformation of any retained austenite to martensite will cause a rise in hardness, and breakdown of the martensite causes softening. Both actions may proceed simultaneously at varying rates. Martensite may be composed of Fe and elementary C (either in or out of solution) and, on tempering, the C combines with some of the Fe to form a mixture of ferrite and carbide. The theory is considered to be capable of explaining temper brittleness and long period embrittlement. JCC (5a)

Some Aspects of the Patenting Process. G. K. RYLANDS. *Wire & Wire Prod.*, Vol. 14, Feb. 1939, pp. 103-106, 13[illegible]. The development of the patenting process is historically followed and the importance of quick cooling for the desired microstructure in wire steel explained. The microstructure should show an entire absence of pearlite. Small quantities of free ferrite are generally unavoidable in low C material, but as long as the quantity is small and pearlite absent, the physical properties of the wire are not materially impaired. In well-controlled Pb patenting furnaces, grain size varies little and does not affect ductility. Patenting equipment and quenching in Pb or salt baths is described. [These statements do not agree with those of B. L. McCarthy regarding the proper structure for patenting; he favors fine pearlite. See *Metals and Alloys*, Vol. 7, Apr. 1936, p. MA 182 R/3.—O.E.H.] Ha (5a)

Phase Changes in 3.5 Per Cent Nickel Steel in the Ac_1 Region. I. N. ZAVARINE (Mass. Inst. Tech.) *Metals Tech.*, Vol. 6, Feb. 1939, T.P. 1031, 10 pp. Original research. A carbon steel and a 3.5% Ni-0.30% C steel were repeatedly heated just to the Ac_1 temperature and cooled a few degrees below this temperature, the time for one cycle being approximately 45 min. With the C steel, increasing number of cycles softened the steel and brought about spheroidization. With the Ni steel, however, increasing number of cycles increased hardness and resulted in the formation of a 2-phase structure, in which the second phase did not correspond to any of the structures found by quenching C steel. The increased hardness was attributed to the decomposition of the new phase on cooling. The nature of the new phase can only be determined by a better knowledge of the Fe-Ni-C diagram. JLG (5a)

Action of Hydrogen on Metals (Einwirkung von Wasserstoff auf Metalle) W. BAUKLOH. *Chem. Fabrik*, Vol. 11, Sept. 28, 1938, pp. 449-455. Review. Decarburization by H_2 is dependent on the temperature and pressure of the gas. If the temperature is high enough, no decarburized layer is found on the steel, owing to the diffusion of C to the surface as fast as decarburization takes place. When cast iron is decarburized, a decarburized layer of about 0.9-1.7% C is produced because the C diffusion is regulated by the maximum solubility of C in γ-iron at the temperature of the test. Since the diffusion rate of H_2 is lower in γ-iron than in α, the decarburized zone reaches a maximum when the steel is maintained at the critical. Decarburization decreases with C below the critical but increases above. At the higher temperature C, being in solution in the iron, diffuses readily to the surface to react with the H_2. PCR (5a)



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Transformations in Hypoeutectoid Steels during Heating. A. S. ZAV'YALOV & Z. N. KRASIL'SHCHIKOV. *Metallurg,* Vol. 13, Nov. 1938, pp. 35-47. In Russian. Research. The processes of transformation of steel were investigated during heating in an isothermal medium. Microanalysis and dilatometric studies show that the Ac_1 and Ac_3 points depend not only upon the chemical composition, but also upon the speed of heating in the intercritical temperature interval (for Ac_3) and in the subcritical temperature interval (for Ac_1). The smaller the speed of heating in the intercritical and subcritical temperature intervals, the lower will be the positions of Ac_3 and Ac_1, respectively. If there are any carbides present, their "critical" temperature of solution will be affected, not only by the speed of heating but also by the dispersion of the carbides. Heating above this "critical" point will produce considerable changes in the physico-chemical properties of the steel, especially the increased stability of the austenite, which is due to the rapid growth of the grain after the carbides had dissolved and the decomposition centers of the austenite had disappeared. BZK (5a)

Carbide Formation during Carburization. A. L. NEMCHINSKII & V. A. DELLE. *Metallurg,* Vol. 13, Dec. 1938, pp. 55-60. In Russian. Research. During the carburizing of C steel with wood charcoal or with a mixture of wood charcoal (60%) and $BaCO_3$ (40%), the saturation of the steel with C is not limited by the Acm line of the Fe-C diagram but continues to the formation of carbides. The limit of saturation is less with C than with a mixture of C and $BaCO_3$. At higher temperatures of cementation, the carbide formation is sometimes slower than at lower temperatures. This may be due to the formation of a carbide network at high temperatures, which hinders the diffusion of the C into the austenite grains. Cr steel has a greater speed of carbide formation than plain C steel. The limit of saturation is higher for Cr-Ni than for C steel. BZK (5a)

Scaling and Decarburization of Carbon Steels (Verzundern und Entkohlen unlegierter Stähle) G. BANDEL. *Stahl u. Eisen,* Vol. 58, Nov. 17, 1938, pp. 1317-1326. Review. A very thorough review of the literature up to 1937, dealing with both the theoretical and practical aspects of the subject. Special attention is given to intercrystalline oxidation effects; strain during scale formation may cause surface checking of the steel. The reactions of pure gases with respect to scale formation and decarburization are discussed as well as the effects of mixtures of gases and of impurities in the gases. Recent developments on controlled atmospheres are reviewed. 85 references. SE (5a)

5b. Non-Ferrous

M. H. MAWHINNEY, SECTION EDITOR

The Influence of Static Stress and Heat-treatment on the Intercrystalline Corrosion of Some Wrought Aluminium Alloys. J. D. GROGAN & R. J. PLEASANCE (Natl. Physical Lab.) *J. Inst. Metals,* Vol. 64, 1938, Advance Copy No. 822, 16 pp. Original research. The intercrystalline failure under static stress of an Al alloy containing 3% Cu and 20% Zn, and of kindred alloys in the form of wrought heat-treated strip and the influence of heat treatment on the sensitivity of the alloys to such failure were examined. The sensitivity increases with the amount of Zn in solid solution. The failure in air is similar to that in NaCl solution, but more rapid in the latter. Failure usually occurred with almost no elongation. "Y" alloy and a 4% Cu alloy were also examined. These materials, rapidly cooled from the solution treatment by quenching in cold water, are free from the intercrystalline attack when submitted to sea-water spray, and in this case corrosion is not influenced by the imposition of static tensile stress in the material during exposure. Materials more slowly cooled, as in still air, are more susceptible to intercrystalline corrosion, which is markedly stimulated by the imposition of static stress. JLG (5b)

Highly Ductile Al-Mg Alloys Resistant to Corrosion (Les Alliages Aluminium-Magnésium Résistant à la Corrosion et à Grande Ductilité) JEAN HERENGUEL. *Métaux et Corrosion,* Vol. 13, Oct. 1938, pp. 177-180. Research. Alloys of 99.7% Al with varying additions of 0.3%, 1.5% and 2.5% Mg, and 0.2%, 0.4% Mn and with 0.3% Mg and 0.4% Mn, and 1.5% Mg and 0.4% Mn, were annealed for 2 hrs. at 400°, 450°, 500°, 550° and 600° C. The results indicate that 0.2% Mn addition to Al increases the grain size 6 times in alloys that were rolled to 50%. On the other hand, additions of Mg refined the grain size of Al alloys; the more Mg the more evident becomes the grain refinement. Addition of Mn to low Mg-Al alloys increases the grain size, but in 1.5% Mg-Al alloys, the effect of Mn additions is completely eliminated. The annealing temperature should not be greater than 525° C. The grain size of all alloys was seriously influenced by the rolling before annealing. Low Mg alloys are excellent for stamping. GTM (5b)

Recrystallization Process with Particular Consideration of Duration of Annealing and of the Speed of Heating in a Commercial Al-Mg Alloy (Der Rekristallizationsvorgang unter besonderer Berücksichtigung der Glühdauer und der Erhitzungsgeschwindigkeit bei einer technischen Al-Mg-Legierung) H. BORCHERS & H. J. MIKULLA. *Aluminium,* Vol. 21, Jan. 1939, pp. 6-23. Original research. The very dominant importance of the phenomena occurring in the solidification of metals and alloys with respect to their further treatment and use is at first theoretically discussed. The view that potential and kinetic energy of a disturbed crystal must reach a definite value (depending on the material) in order to stimulate the regeneration of a crystal, must be modified, as the present research shows clearly that heating velocity and duration of annealing have a determining effect. The exhaustive metallographic and X-ray examination of a commercial Al-Mg alloy clearly established 3 stages of recrystallization: (1) Formation of the nucleus; (2) subsequent growth of the grain; and (3) the surface recrystallization. The nucleus formation is largely influenced by the rate of heating. Simultaneous high rate of heating and short annealing at high temperatures leads, even in the critical deformation range, to a larger number of nuclei and thus to a finer grain than a long annealing at a low rate of heating at lower temperatures. Nucleus formation is a spontaneous phenomenon, entirely independent of time, that starts at the moment when potential and kinetic energy have reached the value necessary for the respective material. The grain growth that occurs because of the still remaining energy after the nucleus formation is, however, dependent on time and proceeds very uniformly. The last stage, the surface recrystallization, is a process during which the coarsening of the grains proceeds discontinuously, and depends largely on the duration of annealing and temperature. Surface recrystallization takes place only when at any place the intermediary substance between the grain boundaries is broken, and occurs after long annealing as well as at low temperatures—conditions under which this phenomenon had not been previously been observed. Sometimes an annealing time of only one second was sufficient to obtain regeneration of a disturbed grain; the material used in the tests was composed of 8.80% Mg, 0.25% Mn, 0.24% Fe, 0.16% Si, remainder Al. Tests and evaluation of grain size are described in detail. 12 references. Ha (5b)

Age-hardening of the Ag-rich Ag-Al Alloys. HIDEO TAZIRI. *Tetsu-to-Hagane,* Vol. 24, Apr. 25, 1938, pp. 357-370. In Japanese. Using 15 Ag alloys containing 4-11% Al, the Ag-side of the Ag-Al diagram was studied by means of the dilatometer and microscope. The boundary of $\alpha + \gamma$ and γ fields lies at about 7.7% Al. The age hardening occurred in the alloys containing 5.6-9.5% Al, which were subjected to quenching at 450°-720° C. and tempering at 200°-350° C.; Vickers hardness numbers obtained after these treatments were 300-365. The hardening rate of alloys containing more than 7.7% Al (which corresponds to the composition Ag_3Al) differs from that of alloys containing less than that amount of Al. In the former, maximum hardness is readily obtained after tempering a short time, while in the latter at least several hours are required. Owing to refining of the grain at the eutectoid reaction at 600° C., an alloy quenched from above this temperature has higher hardness than if quenched from below. The age-hardening of these alloys is attributed to the formation of β' phase (Ag_3Al) through the reaction between α- and γ-solid solutions at 420° C. TS (5b)

An Investigation of Super-duralumin. H. NISHIMURA. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Nov. 1938, pp. 557-562. (See also *Metals and Alloys,* Vol. 9, Aug. 1938, p. MA 501 L/2.) In Japanese. Original research. Al alloys containing Cu and Mg in the proportion of 4:1 or 4:1.5 and small quantities of Mn or Mn and Si were prepared and rolled into sheets. These were quenched from 500° C. and then aged at room temperature or tempered at 50°, 100° and 150° C., and changes in hardness were observed. The addition of Mn retards somewhat the age-hardening at room temperature, but tempering at 150° C. gives rise to marked hardening, in contradistinction to the Al alloy with only Cu and Mg; this was concluded to be due to dissolution of Mn in Al solid solution. Mn + Si also retards the age-hardening at room temperature by the displacement of range of separation of "S" compound. NS (5b)

Temperature Measurements (Temperatur-Messung) A. VON ZEERLEDER. *Aluminium,* Vol. 21, Jan. 1939, pp. 24-26. Methods for, and points to be observed in measuring temperatures, especially in connection with the working and heating of Al, are discussed. Permissible tolerances are given as follows:

	Temperature range, °C.	Tolerance in °C.	in %
Melting	650-800	± 20	± 3
Precipitation annealing	450-550	± 5	± 1
Hot-rolling	400-500	± 20	± 4½
Soft-annealing	270-410	± 25	± 8
Hardening and tempering	100-200	± 2	± 1

Thermocouples and their temperature ranges and fields of applications are described. Ha (5b)

6·WELDING AND CUTTING

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

Commercial Weldery. A. E. & M. W. GIBSON (Wellman Engineering Co.) *Welding J., N. Y.,* Vol. 18, Feb. 1939, pp. 77-84. Practical. This paper (presented in extended abstract form) received the Grand Award of the $200,000 program sponsored by the James F. Lincoln Arc Welding Foundation. In this analysis of a commercial weldery, an endeavor is made to point out the fundamental principles upon which success is built: Management, design, production, technique and research. The reduction of costs by the reduction of labor is emphasized. The success of every weldery is built on the interest, belief in welding and encouragement of some one executive with authority to act. Regardless of the knowledge of the subject, and the enthusiasm for it among subordinates, little progress can be made unless an executive in the organization is keen for welding. A wide awake competent welding supervisor with the ability to handle men should be put in supervisory charge of the shop. He must have a knowledge of welding costs, strength of material, metallurgy, metallography and machining operations. The nick-break test is stated as one of the most difficult for an operator to pass, and is used in operator qualification and training. In 5 year's use, the nick-break test has not failed accurately to judge the operator's ability. In view of the developments constantly being made in welding equipment, welding machines are depreciated over a period of 5 years, and, in turning them in, no book loss is sustained. The d.c. welding machines are so sturdily built that little or no upkeep is necessary over the period that they are kept in the shop. The electrode cost is so small a part of the over-all cost of welding that the added ductility secured by using heavily-coated electrodes justifies the small extra cost. Heavy cast Fe tables having suitable bolt slots for set-up work and for clamping work preparatory to tacking are used. Tables are indispensable for a properly constituted weldery. In preparation of steel for welding, shears and power or friction saws are required. Heavy sections unsuited for mechanical cutting are shaped with a gas torch. In addition to the required number of hand torches, it is desirable to have one or more mechanically operated gas cutting machines. No properly constituted weldery can afford to be without positioning machines. A structure, once fastened to a positioning machine, can be quickly revolved into proper position for welding, thus eliminating the delays incident to desired setting with the use of the crane. The extent to which proper tools for bending metal eliminates welding labor is too little appreciated. One stroke of the press will eliminate a butt weld, if the design called for the welding of the detail with 2 plates. The design of fixtures for aligning metal to be welded is worth much study as an aid in reducing labor. In almost all industrial localities, heat-treating equipment is available as a commercial service to the trade, and if the quantity of work to be treated is not large, it may be best to depend upon other companies to do the work. Investigation and research have become necessary functions of a successful weldery. Qualifying a welder for code work necessitates the use of a testing machine for determining the ultimate and yield points. When research work is carried on, other equipment, such as fatigue, impact and hardness testing machines, are required. The use and value of the metallurgical microscope is also generally recognized. There is great commercial advantage in being able not only to fabricate welded equipment, but also to machine it. The opportunities for revolutionary design with welding are unlimited. Only lack of inspiration and thought on design prevents the transformation of small mechanical details into the more economical welded construction. Guess work must be eliminated on the part of the welding operator, and each weld made in accordance with the calculated weld strengths determined by the engineers. The flat rate basis of estimating often results in loss of orders, which would be obtained if correctly figured. Labor and burden rates should be established to cover all operations. Every foreman in the shop should have a labor estimate available and be held accountable for producing the work in the time figured. Some such method of labor control is essential for efficient management. In conclusion, one cannot review the industrial progress of the past few years without realizing that no factor has contributed more to that progress than welding.

CEJ (6)

The Application of Resistance Welding to Small Parts. PAUL G. WEILLER. *Welding J., N. Y.,* Vol. 18, Feb. 1939, pp. 98-102. Practical review. Whenever a new material goes into parts that must be welded, it is safe to assume that they *can* be welded, though the working out of the proper conditions may require a great deal of experimentation. Generally speaking, metals can be divided into 2 distinct groups in respect to their behavior when they are being welded. One group contains Pt, Fe, Ni and some alloys. These metals will coalesce when heated under pressure at temperatures considerably below their melting point. Pt, for example, can be welded at 700° C., while its melting is at about 1800° C. Two pieces of metal can be joined at any temperature within this range. For steel, the range is not so wide. The other group, comprising nearly all other metals and the majority of alloys, ferrous and non-ferrous, has a sharp melting point. They remain solid and non-coalescing up to the melting point and liquefy suddenly when the melting temperature is reached. The outstanding example of this group is pure Cu. Metals with a wide welding range can be successfully spot-welded, either with a short time (1 or 2 cycles) or with long time (5 or more cycles). Metals of the second group can be welded only with short time impulses. It may be assumed that any structure that can be produced by melting and cooling slowly or rapidly can be produced in a spot weld. Reliable pressure control is as important as accurate timing. The greater the electrode pressure employed, the more power is necessary to make a weld. Oil or iron oxides, or even a slight coating of rust, have little or no effect on welds. Brass or other Cu alloys must be bright for spot welding. A recent practical application is that of tipping fountain pens. At present, fountain pen nibs are tipped with osmiridium grains at a rate of 30/min. Watch cases, typewriter spools and table knives are among other applications. Welding has found some practical application in place of soldering on radio receiver chassis and will undoubtedly make great inroads into the consumption of solder, but progress will be necessarily slow. CEJ (6)

Testing and Inspection of Arc Welded Joints. W. H. SIMON. *Welding Ind., London,* Vol. 6, Oct. 1938, pp. 299-303; Nov. 1938, pp. 349-354. Practical review. An account is given of the various methods now in use for testing arc-welded joints. The safest and most reliable method of testing welds is by the use of X-rays. It is believed that the present state of development of arc welding electrodes renders the application of X-ray testing in the majority of cases unnecessary. The magnetic method is important because of the simplicity of the process and the high sensitivity for the detection of even small flaws and fissures or slag inclusions. However, the sensitivity decreases with the depth of the defects. To ascertain the depth of penetration of the crack, it is necessary to use a milling or grinding tool. a.c. or d.c. magnetic detectors may be used; however, d.c. penetrates the plate much better than a.c. CEJ (6)

Spot-welded Joints, Data and Procedure for their Design in Various Metals. L. H. FROST (Elec. Controller & Mfg. Co.) *Product Eng.,* Vol. 10, Jan. 1939, pp. 15-18. Practical. Sheet surfaces to be spot welded must be flat, so that pressure required for welding will not be wasted in forcing warped areas together. When welding near the edge of the material, enough metal must be allowed between the weld and the edge to prevent burning or melting of the edge. Deflection of the electrode arms because of heavy welding pressure is another cause of trouble. Examples of typical designs are given to show the best spot welding procedure. Charts give, for various thickness of sheet, correct spacing and maximum tear and shear strengths; transformer input and electrode pressures for various thicknesses of mild steel are also plotted. Many useful data for designing spot welds in Al, Cu and brass are also given. Ha + FPP (6)

Welding as Applied to Coils and Tanks. MARSELIS POWELL (Whitlock Coil Pipe Co.) *Ind. & Welding,* Vol. 12, Mar. 1939, pp. 16-19. Practical. In the manufacture of a round pipe coil, lengths of pipe can be welded together while still straight by the resistance welding method, or, if the coil is being made of some alloy not readily resistance welded, by either welding with the electric arc or oxy-acetylene. Then this long length is put through the bending rolls as one piece, the welds being bent the same as the pipe. The manufacture of zigzag or oval coils is somewhat different. The lengths of pipe are bent and welded together after bending, either by the resistance method or which ever method seems most feasible for the alloys being used. Closely connected with the manufacture of coils is the manufacture of welded tanks for use with the coils. In the training of welders, the use of X-ray examination is a very quick and excellent way to point out to a welder his faults and show him how to correct them. Nearly every tank manufacturer has some means of revolving tanks on powered rolls. Most of these mechanisms are driven by electric motors. Probably the best method is the use of an air motor that operates through a reduction gear. The big advantage is that the speed changes of the air motor can be controlled by the welder through a foot pedal. CEJ (6)

Examples in Design of Welded Structures. Part II. Tests with Varying Gauges of Electrodes. J. WRIGHT. *Welding Ind., London,* Vol. 6, Sept. 1938, pp. 292-296. Practical experiments. Maximum economy can be accomplished by using the largest diameter electrode that can be adopted for the work at hand. Fillet and butt welds were studied microscopically and by a hardness survey. In comparing the weld tests carried out, using single runs of heavy gauge electrodes and those using multiple run tests using No. 10 and No. 8 gauge rods, from a practical point of view, the heavy electrodes give as good a result as that produced by several runs of lighter rods. Greater thermal disturbance in the parent metals and deposited metal of a coarser texture is obtained with the heavy electrodes. CEJ (6)

Zinc Welding and Zinc Soldering within the Four Year Plan (Die Zinkschweissung und Zinklötung im Rahmen des Vierjahresplanes) K. H. WISBROCK. *Tech. Zentralblatt prakt. Metallbearbeit.,* Vol. 48, Dec. 1938, pp. 873-876. Original research. The object of the paper is to show how Zn instead of Sn-solder may be employed for the joining of galvanized sheet of 0.75-2 mm. thickness with an acetylene-air burner. For sheet thicker than 2 mm., the use of O instead of air is recommended. The execution of the soldering and welding is described in great detail. Tensile test data obtained in the *Staatliche Materialprüfungsanstalt, Darmstadt,* are tabulated, showing "satisfactory strengths" of butt welded sheets. Further tests on soldered galvanized sheets yielded superior strength in comparison with 40% Sn-solder. Corrosion tests proved that the parent metal is corroded much faster than the joint if the latter has been properly cleaned. EF (6)

Single-pass Electric Welding of Unfired Pressure Vessels. ROBERT M. WALLACE (Griscom-Russell Co.) *Welding Engr.,* Vol. 18, Jan. 1939, pp. 17-25. Experimental. The new single-pass method of welding has definitely taken its place in producing quality welded pressure vessels. Inasmuch as all the welding is done in one pass, it is necessary to have all seams properly backed up. The use of a Cu bar for longitudinal seams and a Cu ring for girth seams has been successful. Physical test results are presented that show that the single pass, high current method gives approximately 6% higher values than usually obtained with manual bead welding. There is no appreciable loss in dimension due to welding under this process. The future should show even greater possibilities in its application to alloys used for heat exchanger service subject to high temperatures, high pressures and severe corrosion. CEJ (6)

High Speed Welding. Part III. H. MARTIN. *Welder,* Vol. 10, Nov. 1938, pp. 328-329. Suggests the use of straight gap welds in order to avoid the preparation of the edges before welding. The use of a curved backing-up strip enables the full penetration of the plate. The gap between the plate edges should be only 1/16 in. wider than the overall size of the electrode coating. The parallel sides of the weld, and therefore, the uniform rate of contraction through the thickness of the plate, will be found to produce much less transverse distortion than a vee weld. A close butt weld may be used using an electrode that will give exceptionally deep penetration. Welds made at high current strengths and with large gage electrodes can only be made in the downhand position. CEJ (6)

The Tensile Strength of Deposited Weld Metal. J. SACK. *Welding Ind., London,* Vol. 6, Nov. 1938, pp. 341-344. Discussion. It is no longer correct to require, in specifications, an upper limit for the tensile strength of deposited metal. This requirement originated from an assumed relation between the variation with composition of the tensile strength and the brittleness of the material. The relation is valid for ordinary C steels but it no longer holds for modern welding materials. This requirement leads to the use of welding rods of poorer quality than would be used if the obsolete requirement were omitted. CEJ (6)

6a. Ferrous

Welding Coated Steel. A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN (Welding Res. Comm.) *Welding J., N. Y.,* Vol. 18, Feb. 1939, Suppl. pp. 33-43. Excellent general review. In the welding of galvanized Fe, no particular trouble is encountered in either fusion or bronze welding. Spot welding requires comparatively high currents (25-50% higher than for cold-rolled steel), high pressures and short times are necessary if the Zn is not to be burnt seriously. Ni clad steels are welded by means of the usual procedure, but the Ni weld must be contaminated with as little Fe as possible. In butt welding, the clad side is usually welded last. In metal arc welding, a short arc (1/16 to 1/8 in.) is absolutely necessary for the Ni weld. A slightly reducing flame is used for oxy-acetylene welding. The same procedure is used for welding Monel clad steel as for Ni clad, except that a Monel filler rod is used. In welding stainless clad steel there is less difficulty with gas absorption than with Ni clad, but the effect of Fe is more dangerous. Successful welds have been produced in Sn plate, terne plate, and Cr and Cd plated steel. Fe pickup in welding Cu clad steel is lower than in welding Ni clad. The general belief is that rust and scale have no effect on fusion welding unless the coating is thick and flaking. Unquestionably, thick oxide greatly hinders spot welding of mild steel, but temper colors have no effect. 114 references and 9 suggested research problems are appended. CEJ (6a)

Welded Plant for Special Service. E. W. ELDIN. *Welder,* Vol. 10, Dec. 1938, pp. 363-364, 369. Descriptive. Galvanizing baths and salt baths vary widely in size, from small pressed vessels to the large baths necessarily involving a considerable amount of welding. Even for the smaller baths, plates seldom much less than 1 in. thick are used. Suitable preparation of the edges of the plate is necessary for metallic arc welding. Large electrodes can be used with advantage, but it is advised that the earlier runs, likely to come into contact with Zn, be made small enough to derive full benefit of the normalizing effect of superimposed runs. With the molten Zn at a temperature not exceeding 460° C., the attack on the steel by the Zn will be so slow that the bath will have a potential life of years. At 500° C., the rate of attack will be alarming and the potential life of the bath limited to days. The container is usually constructed of high quality mild steel with a C content of about 0.15%, as higher C steels are rapidly attacked. The stainless and heat resisting steels are of no value for galvanizing baths. The smaller baths used for cyanide hardening or tempering seldom give trouble. At 500° C., there is little reaction between the mixed nitrates and mild steel while at 600° C. reaction does take place. CEJ (6a)

Welded Joints in Carbon-molybdenum Piping. R. W. CLARK (General Electric Co.) *Welding J., N. Y.,* Vol. 18, Jan. 1939, pp. 37-44. Review plus research. C-Mo steel, because of its good physical properties and resistance to creep at high temperature, has been generally accepted as the base material for the pipe in modern power stations, and welding is the most satisfactory method of joining the pipe. Difficulties in welding, such as cracking and distortion, are usually associated with thermal stresses resulting from the sharp temperature gradient between the molten weld metal and the adjacent base metal. Creep tests by the relaxation method have demonstrated that holding this material at 1100 to 1200° F. for 1 hr. per in. of thickness will greatly reduce the residual internal stresses. Experience has shown that a combination of preheating and concurrent heating is one of the best preventives against cracking, while stress relieving will not remove cracks once they are there. Deflection curves of strips cut from pipes show the most deflection for the pipe welded at room temperature and tested in the as-welded condition, and a decreasing amount as the preheating temperature was increased. CEJ (6a)

Crater Formation—Its Causes and Consequences in Welding (Le Rochage, Ses Causes et Ses Conséquences en Soudure) D. SEFERIAN. *Rev. Soudure Autogène,* Vol. 30, Dec. 1938, pp. 558-561. Practical. The formation of craters is more accentuated in torch welding, and occurs after the solidification around the head, together with more or less harmful blow holes. This defect originates in the alloy rather than in the welder, and results from the chemical reaction of alloying elements during fusion. It consists of an evolution of CO according to the equation $FeO + C \rightleftarrows Fe + CO$. Remedies are: (a) Reducing the C-content below 0.2%; (b) increasing deoxidizing additions with rising C-content. Deoxidizer contents suggested for steels with C not higher than 0.30% are: Si/C at least 1 and Mn/C at least 4; (c) using deoxidizing fluxes such as Si- or ferrosilicon flux; the weldability of steels up to 0.25% C can be improved in this way; and (d) welding in a reducing atmosphere. Photographs and micrographs are shown. RPS (6a)

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Figure (1)

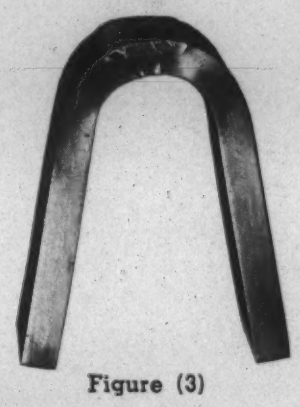

Figure (3)

Figure (2)

TECHNICAL DATA

The proper method of welding 4-6% Cr. Mo. alloy steel is to maintain a preheat of 400° - 600°F. while welding, and subsequently heat treat at 1650°F.

Figure 1 shows a bend test of 4-6% Cr. Mo. weld joint so welded with ARCOS Chromend 5M.

Figure 2 shows failure due to no preheat or subsequent heat treatment.

Figure 3 shows that it is possible to weld 4-6% Cr.Mo. without preheat and heat treatment. *It can be done* with the proper ARCOS Electrode.

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Simplification of Machinery. Manufacture by Use of Electric Arc Welding. JOHN THOMSON. *Welding J., N. Y.*, Vol. 18, Feb. 1939, pp. 88-91. Practical. There are many parts of standard machines that may, with advantage as regards both economy and utility, be made of weldings instead of castings. The advantages are much greater where a machine has to be made on short notice for a special job, and where only one of each part may be required. In such cases stock material may often be used for weldings, resulting in the machine being completed in a small fraction of the time required to make the machine with castings. The design and manufacture of one such machine is described by the author. The machine, designed to finish-machine the surface of a 14-ft. diameter roller path, consisted essentially of a table rotating in a horizontal plane 1 in. above the floor level. The driving power was provided by a 25-hp. electric motor working through reduction gears to a rack welded to the under side of the table. On the floor surrounding the table, radial beams were grouted into the concrete. When machining the paths, the work was bolted to these radial beams and the tool holder was bolted to, and rotated with, the table. The machine was completed and in operation 9 weeks after the design of the welded machine was started in the drawing office. The cost of the machine was $3745.20. This is to be compared with a cost of $14,580 and 2 years of time required for supplying a standard boring mill of cast design. The machine described is typical of many which have been built in various parts of the country. CEJ (6a)

Suitability of Some Casing Steels for Field Welding. L. R. HODELL (Carter Oil Co.) *Am. Petroleum Inst.*, Nov. 1938 Meeting. *Oil Gas J.*, Vol. 37, Nov. 18, 1938, pp. 103-108. Collection of original data by Phillips Petroleum Co., A. O. Smith Corp., National Tube Co., Republic Steel Corp. and Carter Oil Co. "Weldability" is defined as that quality of the steel that makes it possible for a competent welder, using proper equipment and technique, to puddle the steel without undue difficulty, with the further condition that the steel should be of such a nature that after it has been welded it should be possible to immerse it in water within a relatively short time, such as 1 minute, without unduly affecting its tensile strength or ductility. Tables and curves of physical properties and welding data are given on Mo steel, 0.50% Cu steel, 1% Cu steel, medium C and high C Mn steels. All steels contained from 1.11 to 1.41% Mn. Final conclusions are not drawn, but the data are interpreted as follows: To be considered weldable, the steel should show (1) that at 1 minute and longer time intervals following quenching, the bend samples should average a 90° bend and (2) at time intervals of 1 minute and longer after quenching, the tensile samples should show an average joint efficiency of 85% (this applies to field welding). Using this criterion, which also checks with field experience where available, the Mo steel cannot be regarded as weldable. (However, experience has shown that if a waiting period before quenching of 3 minutes is adopted, this steel can be welded successfully.) The 0.50% Cu steel is considered weldable; the 1% Cu, not weldable; cold-worked medium C steel, weldable; medium C-Mn steel, weldable; and the high C-Mn, not weldable. A detailed test procedure is given for determining the suitability of casing steels for field welding. VVK (6a)

Assembly Plant for the Mass Production of Welded Barges and other Structures, Part I. GEO. F. WOLFE (Dravo Corp.) *Welder*, Vol. 11, Jan. 1939, pp. 2-8. Practical. During the period of development of arc electric welding, the manufacturers of welding equipment have worked together, so that their progress has been astonishingly rapid in the perfection of welding machines and electrodes. In some plants the changeover to welding has been a gradual replacement of previous processes. On the other hand, many industries, and particularly such plants as structural fabricators and shipbuilders, do not lend themselves to this transition without sacrifice of economical operation and often scrapping of expensive equipment adapted only to riveted construction. The use of a complete indoor assembly plant for the mass production of all-welded hulls has cut production time to ⅓-½ that of outdoor assembly. All the various parts of vessels are fabricated in the main structural shop and then brought to the assembly plant in as large pieces as can be conveniently handled. In fabricating a barge of the hopper type, 175 ft. long by 26 ft. wide by 11 ft. deep, extensive use is made of positioning equipment in order to use downhand welding. Hydraulically operated jacking and transferring carriages are used to handle the 100-ton assembly. CEJ (6a)

Recommended Welding Procedure for High-carbon Steels. E. W. P. SMITH. *Welding Engr.*, Vol. 24, Jan. 1939, pp. 28-29. Descriptive. The best procedure for the welding of the higher C steels is to heat above 500° F., weld while hot and cool slowly when the C content is well above 0.30% and to employ intermediate beads or special electrodes (or both) in welding the steels near 0.30% C. If the C or alloy content in the base metal is too high, brittleness will occur regardless of the type of electrode used. Steels with from 0.30% to 0.40% C should be allowed 2 or 3 hrs. to cool; all night cooling is recommended for 0.40% or higher C. CEJ (6a)

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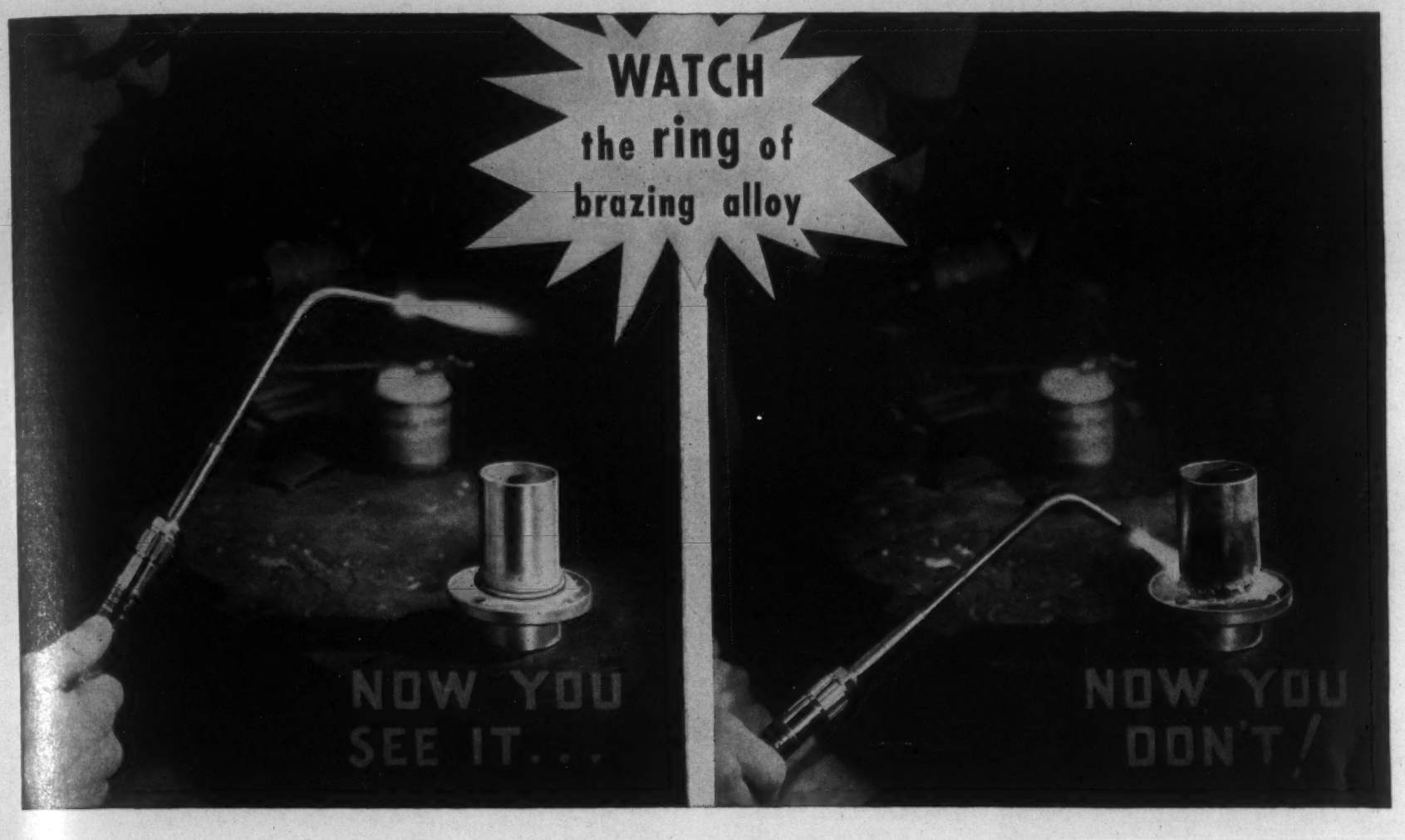

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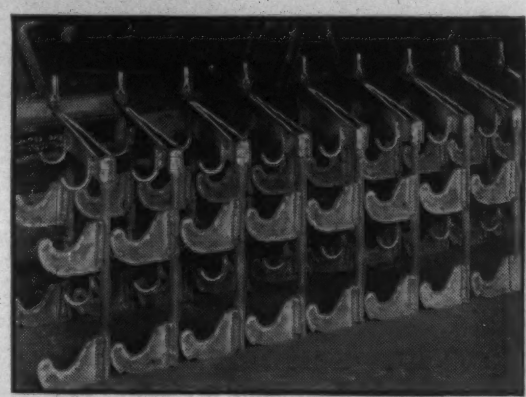
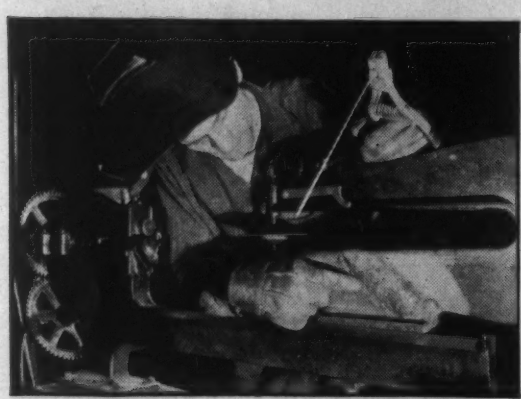
These racks are used for storage of auto parts. Brass is used where machined surfaces rest. Remainder is steel. How would you weld a structure such as this?



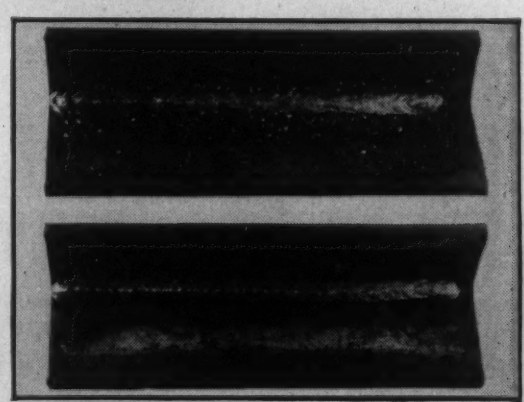


3

The cast iron arm of a circular shear was cracked and repaired, saving $30. How would you weld it? If the weld had to be machined, how would you weld it?

4

These specimens show how "Spatter Film" lessens the tendency of weld spatter to stick, cutting cleaning time 20% to 50%. How is "Spatter Film" used?



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Steel Facing for Dams. R. T. LOGEMAN (Am. Bridge Co.) *Civil Eng.*, Vol. 9, Jan. 1939, pp. 7-10. Practical. During the past few years, construction of a number of gravel and rock fill dams with steel facings has reopened a field for the use of steel that has been dormant for a quarter of a century. This type of construction represents an assembly and application of materials that offers something both new and economical in dam work. Three prime materials are involved: (1) The fill to take the water pressure, (2) the steel face to form the watertight seal, and (3) the concrete in the foundations and cut-off walls to carry the water seal to bedrock or other impervious material. Steel makes an ideal material for dam work. Perhaps the most important feature of the steel facing is its assembly and welding so as to obtain both strength and water tightness. The plates are arranged for lap joints and down welding, and are punched at the shop along all 4 sides at about 12-in. centers, and with about a 2-in. edge distance. The expansion joints, which are generally U-shaped, are lap-welded to the facing plates. Bolts are used for all the joints; the nuts are placed on the exposed surface. All welds are full strength and continuous, with nuts seal-welded to the plates and threads welded to the nuts. Experience shows that a riveted and calked facing would cost about 22½% more than a bolted and arc welded facing. CEJ (6a)

The Soldering of Alloy Steels (Das Löten legierter Stähle) P. SCHAFMEISTER & H. SCHOTTKY. *Metallwirtschaft*, Vol. 18, Jan. 13, 1939, pp. 43-46. Review with bibliography. Discussion of soft and hard solders and fluxes used for soldering alloy steels. German Pb-Sn solders are restricted to 40% Sn. Other soft low melting solders used contain Bi and Cd in addition to Sn and Pb. For stronger joints Cd-Zn solders are used. Hydrochloric acid, zinc and ammonium chloride, phosphoric acid and rosin are used for soldering fluxes. For steels attacked by hydrochloric acid or chlorides, a 50% phosphoric acid flux is used. The hard solders used are brass, German silver and Ag solders. For the soldering of stainless steels, Ni and Mn are added to the Ag solders. Borax and boric acid are used as a flux for the hard solders. In the soldering of alloy steels, the important factors are the influence of the soldering temperature upon properties and so-called solder embrittlement. Alloy steels are seldom soft soldered but are advantageously hard soldered. Rustless steels are soldered only when they are not subject to corrosive attacks. Certain of the austenitic Cr-Ni steels should not be soldered because of their susceptibility to intercrystalline corrosion after heating. Solder embrittlement consists of solder penetrating along grain boundaries. Internal or external stresses assist the solder penetration. GA (6a)

The Effect of Oxygen on the Welding of Steel. A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN (Welding Res. Committee) *Welding J., N. Y.*, Vol. 18, Jan. 1939, Suppl. pp. 1-8. The meager information available suggests that coatings, C and Mn reduce O pick up. Of these, Mn is the most effective. There is a belief that O is responsible for the hot shortness of low grade weld metal. When present as oxide inclusions, O probably has an effect in decreasing the time for initiating the decomposition of austenite on cooling and in increasing the range of temperatures to which steel may be heated without serious grain growth. Deposits from bare electrodes containing 0.95% average 0.2% O_2 are reported. As low as 0.035% O_2 has been reported for deposits from covered electrodes. Roux recommended the McQuaid-Ehn test for qualitative analysis of the degree of oxidation of different parts of the weld. 54 references. CEJ (6a)

Arc-welded Steel Pleasure Cruisers. MILO BAILEY (Bailey Steel Shipbuilding Co.) *Welding J., N. Y.*, Vol. 18, Jan. 1939, pp. 5-13. Descriptive. Presents data comparing a 40-ft. hull made of wooden, riveted steel and arc welded steel construction. Weights are 11,000, 16,500 and 10,500 lbs., respectively. Strengths of hull are 4,576,000, 4,349,900 and 8,940,000 lbs., respectively. For successful fabrication of arc-welded steel craft, the whole structure must be exact, using a solid accurate jig with a properly designed hull and a sequence of operations rigidly adhered to. In order to prevent excessive expansion of the shell plating, the heat of the arc is restricted to a very narrow margin on each side of the weld by using 2 cakes of dry ice on both sides of the weld. The application of dry ice to the welding of bulkheads to frames was used with great success, as all sheets were perfectly flat when finished. CEJ (6a)

Field Welding of Oil Well Casing. E. W. P. SMITH (Lincoln Elec. Co.) & R. L. LOONEY (Big Three Welding Equipment Co.) *Oil Gas J.*, Vol. 37, Sept. 1, 1938, pp. 34, 37-38. Practical. Advantages of welded casing are: 15% less original cost of plain end casing over thread-and-coupled casing, which saving is offset some by additional cost of welding; elimination of leakage at joints; 100% joint efficiency as opposed to 50-70% for thread-and-coupled joints; closer tolerance between inner and outer strings by the use of butt-welded joints; and less resistance to pulling out when hole is abandoned. Welding procedure, types of welds and equipment are described in detail. VVK (6a)

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The Choice of the Filler Metal (Die Wahl des Zusatzmaterials) E. HENRION. *Z. Schweisstech.*, Vol. 29, Jan. 1939, pp. 11-14. Practical. It is not necessary, nor always satisfactory, to use a filler metal of the same composition as the stock. Steels with higher Mn contents are in wide use for welded constructions, and welding metal has to be selected accordingly. Pure Fe is recommended where corrosion resistance is more important than strength. Otherwise, Mn-Si steel with 65,000 lbs./in.^{2} tensile strength, 20% elongation, 38,000-42,000 lbs./in.^{2} elastic limit in the remelted state is used. No additional weld thickness is necessary. The filler metal should contain a certain amount of elements that compensate structural changes during fusing and replace the melting loss. The flame ordinarily should have excess acetylene. An oxidizing flame, however, may also be used; this increases the speed since part of the weld metal burns, thus adding to the heat. A soft, easily machinable surface layer is also obtained. The mechanical properties are slightly impaired by welding under oxidizing conditions. The weld metal, if it has low C content, absorbs some C in a slightly carburizing flame without inducing porosity; such welds are hard (200 Brinell) and sufficiently ductile. RPS (6a)

Welding Processes Are Vitally Important in Oil Field Production. *Welding Engr.*, Vol. 24, Jan. 1939, pp. 15-19. Descriptive. Twenty actual field pictures are shown depicting the arc welding of casings and arc and gas welding of line pipe in the oil fields of Illinois. The average time to complete a joint in a 6-in. casing is 3½ min. Two operators work simultaneously and approximately in opposed position. Using a 3/16 in. rod with about 200 amps., the operators first apply about 4 tack welds, remove the line-up clamps and run the first bead. This is then peened lightly, mainly to remove the slag, and finally the 2 operators apply the final bead. The weld is allowed to cool for 1 min. before the load of the pipe assembly is applied and the casing lowered into the hole in order to position it for the next joint. This cooling time is used in order to prevent too drastic a quench in the mud in the hole. Pipelines are welded in position, using either the arc or gas procedure. For electrolysis protection, the line is provided with insulating flanges and couplings every 1500 or 2000 ft. CEJ (6a)

Some Present-day Problems of Strength in Structural Welding. G. BIERETT. *Welding J., N. Y.*, Vol. 18, Jan. 1939, Suppl. pp. 17-21. Paper prepared especially for the Welding Research Committee of the AWS and translated by G. E. Claussen. Welded structures are afflicted with shrinkage stresses whose effect in soft steel is negligible, but in higher C and alloy steel may be paramount under suitable circumstances. The properties of the heat-affected zone determine the magnitude of the shrinkage stresses. Test for sensitivity to welding is proposed, namely, depositing a single bead on a wide thick plate longitudinally down the middle and subjecting the test plate to a plunger bend test with the bead in tension, the test being continued beyond the first crack until the specimen is completely broken. The test is not presented in its finished form and still requires development work before its true value can be estimated. CEJ (6a)

Development of Welding Electrodes Especially for Steel Construction. K. L. ZEYEN. *Welding J., N. Y.*, Vol. 17, Nov. 1938, Suppl. pp. 21-27. Extended abstract of "Ueber Forschungsarbeiten zur Entwicklung von Schweisselektroden, insbesondere für den Stahlbau," *Stahlbau*, Vol. 6, No. 7/8, 1938. In agreement with other tests results recently published, the impact strength decreases with increasing O and N contents. A relation between the impact strength of the weld metal and the bending test exists only in so far as the lowest impact strength of the non-heat-treated specimens corresponds with the lowest bending angle. At higher impact strength the bending test no longer differentiates. In all cases in which the impact strength is 10 m. kg./cm.^{2} and higher, a 180° angle of bend can be produced with or without cracking. At present it will be necessary to be satisfied with empirical specimens to test for tendency for welding cracks. 9 references. CEJ (6a)

The Application of Welding to Pipe Line Construction. F. JOHNSTONE TAYLOR. *Welding Ind., London*, Vol. 6, Sept. 1938, pp. 263-267. A survey of various methods by which welding has been utilized for pipe work is presented. The use of a bell and spigot joint with internal and external fillet weld provides an open space between the welds that may be taped, and a pressure of one and a half times the working pressure applied to each joint so that there would be no necessity to apply a test to the whole line. The use of a welded core and seamless bands provides a combination design that is highly recommended. CEJ (6a)

Flame Cutting Composite Steels. C. H. S. TUPHOLME. *Machinery, London*, Vol. 53, Oct. 6, 1938, pp. 9-10. Practical. Latest recommendation for cutting stainless-clad steel is to cut from the mild steel side, with the cutting nozzle 10° from the vertical. Larger cutting nozzle or gas pressure and slower cutting speed are used than for equivalent mild C plate. There is some decrease in corrosion resistance, unless the stainless steel is stabilized. JZB (6a)

The Effect of Sulphur on the Welding of Steel. A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN (Welding Res. Comm.) *Welding J., N. Y.*, Vol. 18, Feb. 1939, Suppl. pp. 44-49. Excellent general literature review. The S content of steel is usually limited to a maximum of 0.05% in open-hearth and electric steel, and 0.08% in Bessemer steel, but may be as high as 0.30% in free-machining steels. Unless S is added intentionally, S above about 0.05 or 0.08% may be an indication of poorly-refined steel. Experimental evidence is not sufficient to justify the conclusion that S below 0.05% adversely affects the quality of the weld made by arc, gas or resistance welding. If there are S segregations even below 0.05%, they are evidence of poor quality of the steel and of the probable presence of elements or conditions, such as oxides or slag inclusions, which may be prejudicial to satisfactory welding. 60 references. CEJ (6a)

The Effect of Aluminum on the Welding of Steel. A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN (Welding Res. Committee) *Welding J., N. Y.*, Vol. 18, Jan. 1939, Suppl. pp. 8-11. The major importance of Al from the welding standpoint is its rôle as a deoxidizer and grain size controller. If Al—or, more likely, alumina—is present, the steel may resist austenitic grain growth at higher temperatures than if none is present. Whether or not the steel has been killed with Al has little effect on the properties of the weld. There has been some difficulty in welding nitralloy so that the weld can be nitrided. There is no trouble in oxyacetylene or arc welding Cr-Al heat resisting steels to each other or to plain C and low-alloy steels. 37 references. CEJ (6a)

6a. Non-Ferrous

Metallurgical Investigation of the Natural Aging of Resistance-welded and Riveted Wrought Aluminum Alloys (Metallkundliche Untersuchungen über die natürliche Alterung an widerstandgeschweissten und genieteten Aluminium-Knetlegierungen) WOLFGANG DIETZE. *Forschungsarb. Metallkunde Rontgenmetallog.*, No. 25, 1937, 96 pp. Original research. Commercial German Al alloy sheets were used. Spot welds were made and their strengths determined after times of aging at room temperature up to 40 days. The welds were also examined microscopically and by absorption of X-rays. In order to obtain the greatest strength in the welds, it was extremely important to have the correct welding conditions. Most of the welds in the age-hardenable alloys examined showed porosity, but welded unalloyed Al was practically free from porosity. Welds were made with composite sheet, but they were weaker than welds in the other material. During the first few days after welding, the strength of most of the alloys decreased, but it then increased and the total increase in strength on aging generally was from 10 to 25%. Maximum strength was usually reached after 7 days. Seam welds were also studied and the strength of these was from 35 to 75% that of the original sheet. Fracture always occurred adjacent to the weld. Rivets of several of the alloys were driven and tested after aging. During aging the strength of the rivets in the joints increased from 8 to 20%. 39 references. JLG (6b)

Working and Corrosion Protection of Light Metals (Verarbeitung und Korrosionsschutz von Leichtmetallen) F. OHL. *Oberflächentech.*, Vol. 15, Dec. 20, 1938, p. 249. Joining by soldering of light metals requires solders of heavy metals of low melting point that contain less than 50% Al, or none at all; a temperature of 250° C. is necessary. The oxide layer is destroyed by heavy metal salts acting mechanically or as fluxes. Hard-soldering requires fluxes of mixtures of halides that dissolve the oxide layers; the temperature must be at least 520° C. In gas welding as well as electric arc, the same fluxes as in hard-soldering are applied; electric resistance welding requires no flux, the temperature being about 650° C. An excellent protection from corrosion is available in an amber resin lacquer because of its hardness, elasticity and mechanical and chemical resistance. Light metal sheets coated with this lacquer can be rolled down to half thickness without cracks developing in the coating. Amber coatings will stand temperature variations from —50° to +130° C. without injury; a spray of 3% NaCl solution did not attack it. The lacquer adheres especially firmly to light metal, either eloxated or not. Ha (6b)

Welding of Thin Light-metal Sheets by Resistance Fusion Welding (Schweissen dünner Leichtmetallbleche durch Widerstands-Schmelzschweissung) K. G. GABLER. *Z. Ver. deut. Ing.*, Vol. 82, Dec. 3, 1938, pp. 1399-1400. Descriptive. Thin light metal sheets of less than 0.8 mm. thickness can successfully be welded by resistance fusion welding; the edges to be joined are heated to melting temperature and welded together *without* pressure, the molten material running freely into the open seam. An alternating current of 200-500 amp. at 4-9 v. is used. Welds made in this manner are very corrosion-resistant. Their strength corresponds to that of the soft-annealed material. Examples of procedure are given. Ha (6b)

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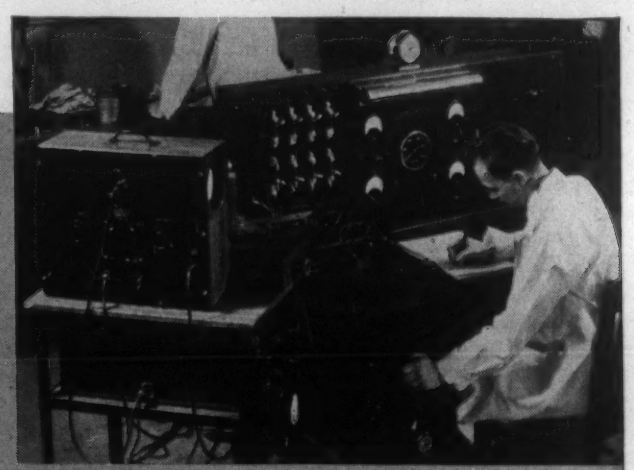
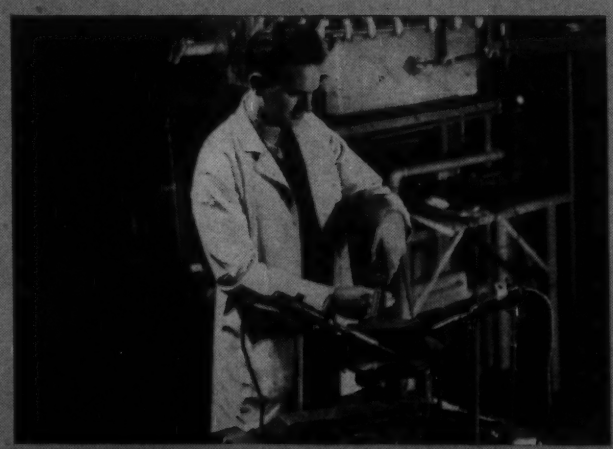
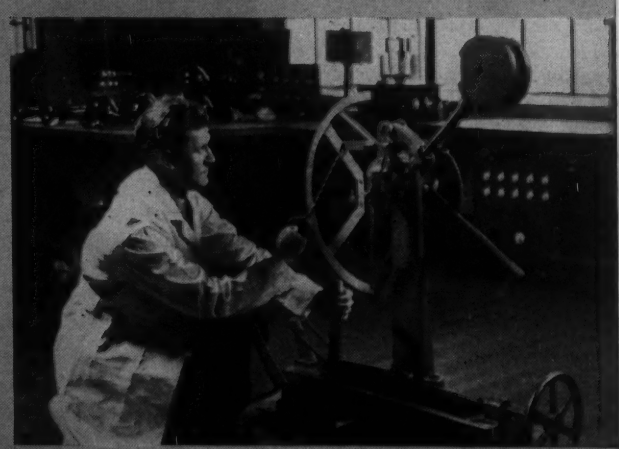


Single unit ignition test for checking the characteristics of ignition systems and the operating characteristics of contacts used in them.



Life test on soldering iron tips. The Mallory Soldaloy tips run continuously 24 hours a day through molten solder and over a steel plate.



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A New Process for Treating Waste from Steel Pickling Plants. M. J. RENTSCHLER. *Iron & Steel Engr.*, Vol. 16, Jan. 1939, pp. 52-62. Descriptive. Pickle liquor is pumped from large storage reservoirs to small agitating tanks, capacity about 2000 gallons. A small amount of fiber in the form of ground newspaper or other waste paper is added and the solution is diluted until the iron sulphate is approximately 5% and the acid content about 2%. Crushed rock quick lime, stored in an overhead steel bin, is dropped by gravity into a 1500 gallon mixing tank where it is slaked with water. The milk of lime is added to the mixing tank until the acid is completely neutralized and the iron entirely precipitated as iron hydroxide. The completion of this reaction is indicated by a sharp rise in the pH of the solution, and is determined in practice with a piece of paper moistened with phenolphthalein. Material is pumped from the mixing tank to pressure filter presses by a plunger type pump. Press cake, containing about 50% moisture, is dropped into a pug mill that pugs the material into a uniform mass and extrudes it in a continuous block form. The block is cut off and placed on trays, which are racked 3-deep onto a car and run into a tunnel dryer where the moisture is removed and the material sets and oxidizes at the same time to form a highly porous product, which is called Ferron. Preliminary laboratory investigations have indicated that the material possesses unusual strength, has excellent insulating properties and possesses resistance to high temperatures. Pilot plant with capacity of several tons per day has produced insulating and fireproof wall board; high temperature insulating brick and plastic; fire proof building blocks and bricks possessing excellent insulating and acoustic properties; pipe covering; finishing plaster; plastic and granulated Ferron, which is valuable in removing H_2S from manufactured gas. Articles made of Ferron cannot burn, decay or scum. The material is proof against termites and can be water proofed. It is easily sawed, cut, drilled, planed and grooved without marked dulling of tools. Nails, screws and staples hold firmly in the product. It is non-corrosive, can be painted, shellacked or varnished; and all cements work well with Ferron. Sanitary Water Board of Pennsylvania has approved the process as a satisfactory method for the disposal of pickle liquor. CBJ (7)

Finishing Solid Gold Jewelry. PAUL A. OLDHAM. *Metal Ind., N. Y.*, Vol. 37, Feb. 1939, pp. 72-75. Practical. Fire skin formed by annealing, fire-scale and flux from soldering are removed by pickling in warm 5-20% sulphuric acid. Loose fire scale is removed by "stripping"; reverse current (work made the anode) with cylindrical sheet iron cathodes is used with an electrolyte consisting of NaCN 4 oz., Rochelle salts 2 oz., potassium ferrocyanide 1 oz., water 1 gallon, temperature 190° F., voltage 6-8 volts, time ½-1 minute. The pieces are then washed in cold water, hot water, dried in sawdust or with steam pressure. Ball burnishing is carried out in a tank containing a solution of dissolved fig soap, neutral soap flakes 1-3 oz. per gallon or a commercial burnishing compound. Polishing and buffing operations are carried out with many kinds of wheels, such as tampico brush, wood and steel laps, walrus hide, felt, muslin and linen buffs, with grease, tripoli and common rouges as abrasives. Grease and rouge are washed off with a solution consisting of ½ oz. mild neutral soap dissolved in 1 pint of ammonia with a gallon of water, used hot (150° F. or over). Formulas for 24 Kt. fine gold solution, green gold solution, 14 Kt. gold solution, light rose gold, dark rose gold and antique green gold solutions are given. CBJ (7)

Practical Pickling of Steel (Zweckmässiges Beizen von Stahl) P. DICKENS. *Stahl u. Eisen*, Vol. 58, Nov. 24, 1938, pp. 1343-1346. Review and practical observations. Describes the 3 general types of oxides that form during the heating of steel: FeO, Fe_3O_4 and Fe_2O_3. With higher temperatures, more FeO forms and less Fe_3O_4 and Fe_2O_3. FeO is more easily dissolved than Fe_3O_4 or Fe_2O_3. The scale formed during heating and rolling is much more easily removed by pickling than the scale formed during heating alone. Scale is more easily pickled off from normalized stock than from box-annealed steel. In box annealing, the atmosphere makes for a more adherent scale. After box annealing, difficulty in pickling may also be accompanied by inferior bend properties after galvanizing; normalized sheets are, therefore, to be preferred for galvanizing. The action of inhibitors is attributed to the greater absorption of the organic substance by the metallic surface than by the scale, so that the metal is protected from the attack of the acid while the scale is not protected. Inhibitors tend to break down as the temperature is raised and, to test inhibitors, the maximum temperature at which they still remain effective should be determined. The less concentrated the acid and the lower the temperature, the more H_2 is absorbed by the steel. More H_2 is absorbed when using H_2SO_4 than HCl, and most when using both H_2SO_4 and HCl. Higher concentrations of acid and higher temperatures give faster pickling. Construction of pickling tanks, pickling of alloy steels, and electrolytic pickling are also discussed. 22 references. SE (7)

7a. Electrolytic Methods

Anodic Oxidation of Aluminium and Its Alloys. J. V. RUSHTON. *J. Electrodepositors' Tech. Soc.*, Vol. 14, 1938, pp. 191-203. Review. The chief anodizing processes are: (1) The Bengough-Stewart, which uses a 3% CrO_3 solution. The operating conditions are: Temperature, 40° C.; current density, 4 amp./ft.^{2}; anodizing period, one hour, during which time the voltage is gradually raised to 50 v. (2) The H_2SO_4 process, using a solution containing 1 to 25% of the acid. The operating conditions depend on the strength of the electrolyte used. Voltages range from 6 to 20 v.; current densities from 1 to 40 amp./ft.^{2}; temperatures from 15 to 22° C. (3) The oxalic acid process, which, although it produces the hardest films, is not widely used. Process (1) produces an opaque gray film; (2), a silvery film; and (3), a yellow film. The color of the films on Al alloys varies with the composition of the alloy. Before anodizing, articles must be degreased. Anodizing racks are of Al, and care must be exercised to prevent the contact becoming insulated by film formation. Otherwise arcing and burning will result when the voltage is raised. Some of the difficulties encountered in anodizing and the method of overcoming them are discussed. These include anodizing porous castings and welded objects, burning, gas traps, pitting, etc. Many difficulties can be prevented by the proper design of the articles. The thickest films are obtained by the H_2SO_4 process, and may be 0.008 in. thick. The production of anodic films for dyeing requires especial attention to the cleaning of the object if uniform coloring is to be obtained. It is difficult to match the color of different sheets. AB (7a)

The Dezincification of Alpha Brass with Special Reference to Arsenic. FREDERICK W. FINK (Battelle Mem. Inst.) *Trans. Electrochem. Soc.*, Vol. 75, 1939, Preprint No. 2, 6 pp. Original research. The presence of 0.02% of As in brass condenser tubes decreases or prevents dezincification of the brass. Experiments showed that the As probably acts as an anodic inhibitor. Dezincification is caused by the solution of Zn at certain Zn-rich areas, the residual Cu remaining then functions as a cathode area. Zn and Cu go into solution at anodic areas, but the Cu is reprecipitated on the cathodic areas. Cells were made with α-brass electrodes (70% Cu and 30% Zn) immersed in NaCl solutions. Little difference was found between As-containing electrodes and As-free electrodes. However, under conditions of differential aeration, in which the anode was buried in sand and the cathode was exposed to the air, As containing anodes permitted less current to flow through the cell than non-arsenical anodes. The As supposedly forms a film on the anode and prevents the attack at the active points. The brass then corrodes more slowly and uniformly, both Cu and Zn ions entering the solution together. AB (7a)

The Electrodeposition of Tin from Acid Sulphate Solutions. II. A. W. HOTHERSALL & W. N. BRADSHAW. *J. Electrodepositor's Tech. Soc.*, Vol. 15, 1939, pp. 31-48. Publication of the Internatl. Tin Res. & Development Council, No. 83. Original research. Three different types of addition agents are required in an acid tin plating bath: (1) Cresol sulphonic acid to retard oxidation of the Sn^{II} to Sn^{IV}; (2) protective colloid, such as gelatin or lysalbic acid; and (3) a hydroxy compound, such as β-naphthol. The authors investigated the effect of 3 different combinations of addition agents on the deposit obtained from the following bath: 30 g./l. of Sn as $SnSO_4$; H_2SO_4, 60 g./l.; cresol sulphonic acid, 100 g./l. Combination (I) 2 g./l. of gelatin and 1 g./l. of β-naphthol. (II) lysalbic acid 1 g./l. and β-naphthol 1 g./l. (III) lysalbic acid 1 g./l., and resorcinol 20 g./l. The baths were compared with respect to covering power, which is the minimum cathode current density that will give a continuous deposit 0.00005 in. thick on a Cu cathode. Bath III had the poorest covering power, which was more than 10 amp./ft.^{2} Baths I and II had a covering power of about 1 amp./ft.^{2}, but, over a period of 6 months, bath II was the more stable. Deposits 0.0001 in. thick were very porous. Non-porous deposits 0.0005 in. thick were obtained from baths I and II at 5-15 amp./ft.^{2}; bath III gave porous deposits at 5 amp./ft.^{2} and non-porous deposits at 10-15 amp./ft.^{2} The deposits obtained from bath I at current densities above 20 amp./ft.^{2} were very porous, even when they were 0.001 in. thick. Cathode agitation considerably reduced the porosity of coatings formed at these higher current densities. The porosity of coatings, after being bent around a 1/32 in. radius, was determined. The smallest increase in porosity was shown by coatings 0.0005-0.001 in. thick, plated out of baths I and II at 5-10 amp./ft.^{2} and out of III at 10 amp./ft.^{2} All 3 baths showed good stability. After being in operation 6 months, there was little change in the Sn^{II} concentration or increase in the Sn^{IV} concentration. The cresol sulphonic acid, which is added to retard oxidation of Sn^{II}, also improves the covering power of the bath. Other benzene and phenol sulphonic acids were less effective than cresol sulphonic acid in improving covering power, but were about equally effective in retarding oxidation of Sn^{II}. Various organic hydroxy compounds were tested as substitutes for β-naphthol, which is added to the bath to produce smoother deposits. Para-isoamyl phenol gave comparable results. Other compounds had the disadvantage that they decreased the covering power. No satisfactory substitutes for gelatin or lysalbic acid were found. Details of the preparation and analysis of the bath are given. AB (7a)

Carbonates in Copper Cyanide Baths. P. S. TITOV & E. N. TIMOKHINA. *Zhur. priklad. khim.*, Vol. 11, Jan. 1938, pp. 35-41. In Russian. Original research. The authors investigated the effect of the Na_2CO_3 content on the operation of the copper cyanide bath of a composition recommended by Pan (*Trans. Am. Electrochem. Soc.*, Vol. 68, 1935, pp. 471-482). They found that with increasing Na_2CO_3 content: The electric conductivity of the bath first increases, then decreases, attaining its maximum at 50-100 g./l.; the cathodic current yield at a current density of 1 amp./dm.^{2} first increases, then decreases, being 90% at 50-80 g./l.; the passivity of the anode remains the same, but the passivating film changes in its character, being transparent at Na_2CO_3 contents above 70 g./l. and consisting, probably, of a hydrate of colloidal cuprous oxide. The cathode polarization and the quality of the deposit are not noticeably affected by variation in the Na_2CO_3 content. A bath whose composition is identical with that recommended by Pan, except for a slightly higher content of free cyanide (10 g/l.), yields good deposits at a current density of 1.0-1.5 amps./dm.^{2} at room temperature, the current yield being 90%. At an anodic current density of 0.5 amp./dm.^{2}, the passivation of the anode is but slight and the loss of free cyanide due to anodic oxidation is small in this batch, which is, likewise, but weakly carbonized by the CO_2 of the air. ORS (7a)

Electrodeposition of Tin from Alkaline Solutions. S. BAIER & R. M. ANGLES. *J. Electrodepositor's Tech. Soc.*, Vol. 15, 1939, pp. 1-30. Publication of the Internatl. Tin Res. & Development Council, No. 82. Original research. A typical stannite bath is $SnCl_2 . 2H_2O$, 12.5 g./l.; KOH, 50 g./l.; glue, 0.5 g./l.; temperature, 60°-90° C.; current density, 5 amp./ft.^{2} If the Sn^{II} content falls below 5.5 g./l., the deposits are spongy; if it is above 15 g./l., the deposit is crystalline and discontinuous, and the basis metal is not completely covered. Even the best deposits are more porous than those from the stannate bath. The cathode current efficiency as Sn^{II} is over 95%. The bath oxidizes on standing, but the stannate formed does no harm. Good deposits can be very readily obtained from the stannate bath over a wide range of Sn concentration (3-90 g./l. of Sn) and operating conditions; but a cathode current efficiency of 90% (as Sn^{IV}) is obtained only under certain conditions. A typical bath is 45 g./l. of Sn, 13 g./l. of free NaOH; temperature, 75° C.; current density, 15 amp./ft.^{2} The current efficiency of a stannate bath is increased by lowering the current density, increasing the Sn content, and raising the temperature. Increase in free NaOH decreases cathode efficiency. The free NaOH in a bath should be about 1/3 the weight of the Sn. The NaOH gradually absorbs CO_2 and the resulting Na_2CO_3 lowers the cathode efficiency. At low current densities, Sn dissolves anodically as Sn^{II}; at high current densities, it dissolves as Sn^{IV} and a film forms over the anode. The solution of the anode as Sn^{II} must be avoided, because as little as 0.2 g./l. of Sn as stannite will produce spongy deposits in a stannate bath. If a film is formed on the anode by a high current density, the anode will continue to dissolve as Sn^{IV} at low current densities, with 80-100% efficiency. However, if the current density falls below 0.5 ampl./ft.,^{2} the film disintegrates and the anode dissolves as Sn^{II}. The critical current density required to first form the film varies from 40 to 100 amp./ft.^{2} at 70-80° C. It increases with temperature, concentration of free NaOH and stannate, but it is decreased by addition of Na_2CO_3. The stannate bath may be satisfactorily operated with insoluble anodes of Ni or Fe. The stannate-acetate bath, which contains Na acetate, has been used in large installations. Its behavior is identical with the plain stannate bath. Addition agents, such as lactic acid rosin, starch, etc., are sometimes added to the stannate bath to give smoother deposits. These substances, however, reduce the cathode efficiency as much as 20%. The analytical control of the plating baths is given. The harmful impurities in commercial Na stannate are $NaNO_3$ and Sb. AB (7a)

Electrodeposition of Tin. The Stannous Ammonium Oxalate Bath. A. W. HOTHERSALL & W. N. BRADSHAW. *Metal Ind., London*, Vol. 53, Dec. 30, 1938, p. 643. Original research. The bath studied does not produce sound deposits over such a useful range of current density as the sulphate baths, but deposits of good quality may be obtained and the bath is easily prepared. In a bath of 50 g. stannous oxalate, 20 g. ammonium oxalate, 15 g. oxalic acid and 2 g. gelatin to 1 liter water, good deposits were obtained at 20° C. over a current density range of 2.5-5 amp./ft.^{2} The cathode efficiency at 5 amp./ft.^{2} was 99.8%. The throwing power, though inferior to the sulphate bath, was fairly good. One of the drawbacks of the oxalate bath has been reported to be the instability of the solution, due probably to increasing alkalinity with use. At pH values over 4.2, a heavy white precipitate forms, but below pH 4.0 the solution remains clear. The original bath pH is about 2.5. A bath maintained at about pH 3.5 by additions of oxalic acid gave satisfactory results after intermittent working for several months. RWB (7a)

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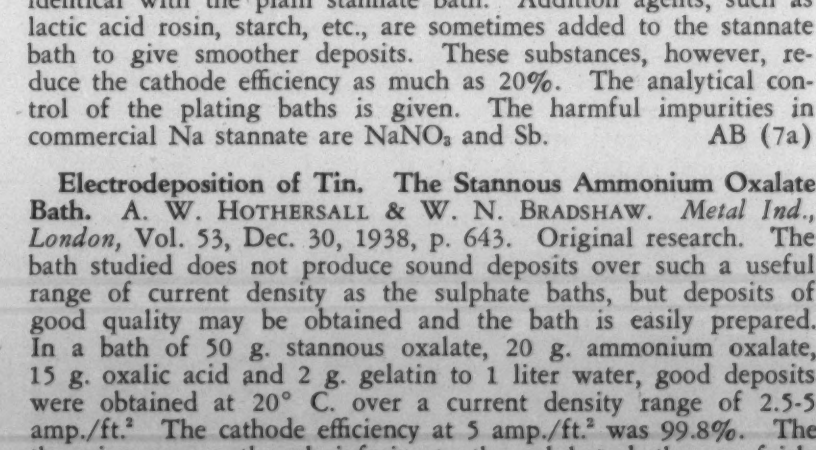

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Current Distribution in Electrodeposition. I. Linear, Cylindrical and Spherical Conductors. CHARLES KASPER (Natl. Bur. Standards) *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 26, Jan. 1939, pp. 11-26. Theoretical. Current distribution is explained non-mathematically in terms of lines of current flow and equipotential surfaces. Uniform current distribution can be obtained only if the electrodes are plane parallel plates, concentric cylinders, or concentric spheres. The effect of throwing power in improving the metal distribution on an irregularly shaped object, when it is electroplated, is small in comparison with the variations in the primary current distribution. A graph is given of the current distribution over 2 eccentric cylinders. The distribution is more uneven over the inside of the external cylinder than over the outside of the internal cylinder. **II. Point-plane and Line-plane Systems.** *Ibid.*, Feb. 1939, pp. 91-109. The current distribution in the point-plane system is an example of 3-dimensional current flow. The current density at any point on the plane is inversely proportional to the cube of its distance from the point electrode. A number of cases of the current distribution in 2 dimensional flow are discussed. These cases consist of current flow between a line electrode and one or more plane electrodes that are either parallel or intersect at right angles. Included are examples in which insulating walls are present. In the simple line-plane system, the current density at any point on the plane is inversely proportional to the square of its distance from the line electrode. If the line electrode lies between a plane electrode and an insulating wall, the latter acts as a deflector of the current and increases the current density on the part of the conducting plane nearest to the line electrode. Appendices contain the mathematical derivations. AB (7a)

Hazards and Safety in Electroplating. M. J. MOLL (Hanson-Van Winkle-Munning Co.) *Occupational Hazards & Safety*, Vol. 1, Feb. 1939, pp. 8-12, 33. Review. With the Cr-plating of a simple steel piece as an example, a flow-sheet of operations is given and the hazards, safeguards and preventives involved in each step discussed. Most serious hazards are (a), in the grinding operations, from flying particles entering the eyes and from dusts entering the nose; (b), in degreasing, from the effect of solvent vapors when inhaled or from the effect of caustic solution on the skin; (c), in acid dipping, from acid fumes and solutions; (d), in plating, from the metal salts and particularly from the cyanide used; and (e), in lacquering, from the solvent vapors as well as from flammability. (7a)

The Importance of Proper Anode Corrosion in the Electrodeposition of Nickel. W. L. PINNER & L. C. BORCHERT (General Spring Bumper Corp.) *Proc. Am. Electroplaters' Soc.*, June 1938, pp. 84-90. **Further Notes on Nickel Anode Corrosion.** W. L. PINNER & L. C. BORCHERT. *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 25, Dec. 1938, pp. 909-910. Original research. The loose particles produced when Ni anodes corrode cause rough deposits unless the anodes are bagged. In low pH Ni baths, cloth bags quickly deteriorate, and it is advantageous to dispense with bags and use the C-type Ni anode that forms an adherent coating of C about itself as it corrodes. These Ni anodes are tested by being corroded for 100 amp.-hrs. in a plating bath. The loose metallic particles are separated magnetically. The anodes are rejected if the loose metallic particles amount to more than 0.04% of the Ni dissolved. The loose material on the anodes may be sand inclusions or slag introduced during casting, or may represent other impurities in the Ni. An increase in the chloride content of a bath increases the per cent of "loose Ni." The amount of loose Ni decreases as the current density is raised. Ni anodes must be selected to suit a particular bath; for example, a high-purity anode may fail to dissolve in a cold bath low in chloride; and a low-purity anode may fall to pieces in a hot Ni bath, high in chloride. A set of cast C-Ni anodes, which in a bath of pH of 2 produced only 0.004% of loose Ni, formed from 10 to 40 times as much loose Ni when the pH was raised to 5.4. AB (7a)

Electrodeposition of Lead on Base Metals. Part I. Behavior of Alkaline Baths with Iron Cathodes at Low Current Densities. SHRID HAR SARVOTTAM JOSHI & T. V. SUBBA RAO. *J. Ind. Chem. Soc.*, Vol. 15, July 1938, pp. 377-382. Original research. Increasing demand for Pb-coated ware has stimulated study for obtaining smooth adherent Pb deposits. Hot-dipped and sprayed coatings have the disadvantage that they are not always uniform and firmly adhering. Rate of electrodeposition of Pb can be varied, as desired, and surfaces with engraving or indentations are coated more easily by electrodeposition. Acid solutions of a nitrate, acetate, lactate, perchlorate, fluosilicate or fluoborate, have been tried. The latter 3 gave comparatively satisfactory results, but the maintenance costs are high and at times almost prohibitive. Attempts were made to electrodeposit Pb from an inexpensive moderately concentrated solution of litharge in aqueous alkaline solutions. The following factors were studied: Current density, temperature, separation (*i.e.* inter-electrode distance), influence of addition agents such as gelatine, tartar emetic, Sb and Th salts, agitation by air bubbles and intermediate coatings of Sb. EF (7a)

7b. Non-Electrolytic Methods

Fast Galvanizing. E. A. MATTESON (Aetna-Standard Engr. Co.) *Steel*, Vol. 103, Nov. 14, 1938, pp. 73-74, 86. Descriptive. The best Zn coating is obtained when sheet is removed from bath as soon as possible after it has reached a coating temperature, as a thinner layer of brittle FeZn is thus formed. Ordinarily, with increasing speed, flux will not clear off of light gage sheets and flux stains, poor coating and dirty bottom rolls often result. Heavy gage sheets can not be run faster as they may not heat uniformly and uneven coatings result. These difficulties have been overcome by placing a second pair of bottom rolls about 30 in. from the first pair and by lengthening the entire galvanizing unit so that distance from second pair to exit rolls remained the same as previously. Greatest benefits from this arrangement are obtained with the heavier gages. Increases in speeds on extremely heavy gages are 50-100%; medium gages, 20-40%; and light gages, 10-15%. Grooving of exit rolls and bath level must be adjusted to prevent heavy coatings. Flux around exit rolls must be kept at proper consistency to prevent its being carried around rolls. Sheets must be free from pickle salts. A single motor operates all rolls synchronously through speed reducers that permit speed changes to accommodate varying roll diameter. MS (7b)

Degreasing and Cleaning Solution for Aluminium and its Alloys. *Light Metals*, Vol. 1, Dec. 1938, pp. 386-387. Review. Alkaline cleaning baths are used to a somewhat greater extent than acid baths; the alkaline bath acts both as a pickling and as a degreasing solution. Water glass is most frequently used as an inhibitor in alkaline baths, although many substances have been recommended. Sailer's process is unique in that a metallic film of Fe is formed on the surface of the Al, and later removed, the idea being that when the Fe film is removed, all surface impurities are also removed. There are many such processes that are not part of ordinary practice, but are illustrative of the sensitivity of Al and its alloys to variations in cleaning mediums and procedure. The combined alkaline and acid (nitric) dip is the customary practice of today. The acid dip is used to remove the persistent white stains (insoluble salts formed in the alkaline dip or washing water). The acid also removes deposits of more noble metals, while the Al tends to remain passive. AUS (7b)

Inhibition of Acid Attack of Metals by Organic Substances (Ueber die Hemmung der Saürekorrosion der Metalle durch organische Stoffe) W. MACHU. *Angew. Chem.*, Vol. 51, Dec. 3, 1938, pp. 853-857. Theoretical. The theories (valve-layer and over-voltage) for the explanation of the mechanism of the inhibiting effect by organic substances added to pickling acid are not correct. The effect occurs because the metallic Fe adsorbs the inhibiting substance to a much larger degree than does the scale or oxide layer. The electric resistance of the oxide layer on Fe in H_2SO_4 is about 0.06 ohm; this was increased to 7.8 ohm by an addition of 1.25% gelatine while the scale itself did not adsorb the inhibitor and therefore was subject to the attack by the acid. Inhibitors consist of 0.03-0.05% solutions of rodine, dibenzylsulfide, diorthotolylthiourea, or of 1-3% solutions of gelatine, chinolin, gum arabic, etc. The protective effect is due to a primary formation of a layer of the inhibitor by adsorption, with such very closely-packed intermicellar capillary spaces that the electric resistance in the border layer metal-solution is high. This reduces the diffusion velocity of the ions, and thus suppresses dissolution of the metal. 6 references. See also *Metals and Alloys*, Vol. 10, Mar. 1939, p. MA 164 R 1. Ha (7b)

Galvanized Coatings. F. L. WOLF & W. E. RENWICK (Ohio Brass Co.) *Iron Age*, Vol. 143, Jan. 19, 1939, pp. 30-35. Original investigation to determine satisfactory methods for measuring weight and uniformity of hot galvanized coatings on castings and forgings. Survey of existing methods for determining Zn coatings leads to the conclusion that there are no satisfactory test methods for hot dip galvanized coatings on castings and forgings of intricate shapes. According to the authors' experience with hot galvanized castings in atmospheric exposure, any material capable of passing visual inspection will possess a satisfactory weight and uniform coating. Results of the investigation showed that weight and uniformity of coating on irregular shapes cannot be controlled in manufacturing process, but tests show that even the thinnest coats offer ample protection against atmospheric corrosion; corrosion is unlikely to occur on bare areas of hot dip galvanized malleable Fe and mild steel when such areas do not exceed the equivalent of a 1/8 in. circle; visual inspection offers ample protection for the purchaser; and, a revised tentative Preece test may be used to check visual inspection (A.S.T.M. A208-38T). VSP (7b)

Cupal Tubes in Place of Copper Tubes (Cupalrohre an Stelle von Kupferrohren) *Oberflächentech.*, Vol. 16, Jan. 17, 1939, pp. 12-13. Practical. Cupal is Cu-clad Al; the Cu is joined to the Al by press-welding and the new metallic body formed has 0.40-0.50 of the weight of Cu. The tubes are clad on one or both sides so that the Cu occupies from 10-30% of the total thickness; the outside diameter of the tubes may be from 2 to 60 mm., and wall thicknesses from 0.25 to 5 mm. Specific gravity will be 3.33-4.5. The tensile strength is 30-45% higher than that of Al. Pipe joints are made by soft-soldering or by flanges. If annealing is necessary to facilitate bending or other working processes, it must be done at 380°-400° C. in a muffle or in a saltbath (55 parts potassium nitrate and 45 parts sodium nitrate), after which the tubes are washed in 10% H_2SO_4 and rinsed. Welding is not possible. The material is used principally in high-frequency furnace apparatus. Ha (7b)

Finishing Gas Station Pumps. E. J. FRUNDEL (Drying Systems, Inc.) *Ind. Finishing*, Vol. 15, Nov. 1938, pp. 22-25. Practical description of methods and installation used by Bennett Pump Plant of Service Station Equipment Co. Briefly describes bonderizing and preliminary treatment of metal pumps prior to coating, such as mild alkali dip, boiling H_2O dip, bonderite (rust proof) dip, chromic acid dip, and air blow off. Baking is done in gas-fired heater type ovens. The prime coat is baked at a temperature of 350° F. for one hr., while the finished coat is baked at 280° F. for one hr. VSP (7b)

Metallizing in the Homestake Shops. B. F. NOONAN (Homestake Mining Co.) *Eng. Mining J.*, Vol. 140, Jan. 1939, pp. 36-37. Metallizing is used particularly for spraying all underground electrical equipment with Zn. Metallizing is used at Homestake to protect against corrosion, to build up surfaces or to produce a new surface different from the underlying metal, and for ornamental purposes. The metals purchased in wire form are 0.1-1.2% C steel, Al, bronze, brass and Zn. The articles that are metallized and the means of applications are discussed. WHB (7b)

The Hot-tinning of Fabricated Articles. E. J. DANIELS. *Ind. Heating*, Vol. 5, July 1938, pp. 642-644; Sept. 1938, pp. 832-833, pp. 1064-1065, 1071; Dec. 1938, pp. 1163-1165; Vol. 6, Jan. 1939, pp. 71-72. Comprehensive review of methods and practices of hot-tinning of various metals, cleaning, use of inhibitors, temperatures and equipment. 25 references. Ha (7b)

Review of the Latest Product Finish Materials. *Ind. Finishing*, Vol. 15, Jan. 1939, pp. 38-51, 55-56, 58, 60, 62, 64, 66-68. An extensive list of finishing materials recently developed, giving their trade-names, properties and applications, and classified under such headings as: Bake finishes, air drying metal finisher, etc. VSP (7b)

Considerations on Tinning of Sheet and Strip (Betrachtungen über die Blech—und Bandverzinnung) W. KRÄMER. *Kaltwalzwelt*, Oct. 1938, pp. 73-76. Practical. The various causes of porosity of Sn coatings are classed as (1) pores due to "external" effects, such as defects caused by improper handling during manufacture or by impurities in the Sn bath (formation of hard Sn or "Scruff") or palm oil bath, etc.; (2) pores due to "internal" effects from the steel used or the pickling conditions. The external effects are most carefully considered, and among others a number of new German tinning machines are described. These include machines with upper equalizing rolls, machines with wiping rolls, machines with oscillating wipers, machines with small tinning rolls and thick backing-up rolls, tandem tinning machines, etc. Possibilities of decreasing the Sn and oil consumption are considered. In all, the paper considers the problem of porosity of Sn plate from the practical point of view, stating that the low Sn deposit common at present is an essential hindrance for processing a pore-free Sn plate. GN (7b)

Corrosion Protection for Magnesium Alloys (Korrosionsschutz bei Magnesiumlegierungen) E. NACHTIGALL. *Korrosion u. Metallschutz*, Vol. 15, Jan./Feb. 1939, pp. 43-48. Review. Methods of providing protective coatings on Mg alloys are surveyed. Spraying and plating, mechanically and electrolytically, are possible but not widely used as the coatings must be very dense, otherwise rapid destruction takes place because of the great potential difference between Mg and coating metal. Spraying with pure Al or Hydronalium (Al-Mg alloy, Mg 5-10%) has proved to be very satisfactory. Anodic oxidation, especially in alkaline solutions (about 5-10% alkali) with alternating current, seems to promise a satisfactory solution, although such layers are not yet free of pores. The bichromate process in 10-20% HNO_3 produces thin but very adhesive layers. Anodic formation of Mg fluorides (in a solution of fluorides in urea) has lately been developed and provides good corrosion protection, but the layers are still somewhat brittle. Phosphate layers have not given satisfaction, and chemical treatment with solutions of Se salts or selenic acid forms a dark film of good chemical resistance which, however, needs protection with a lacquer coating. Other processes that have not yet attained practical importance are discussed. 33 references. Ha (7b)

Diffusion of Zinc and Iron at Temperatures above the Melting Point of Zinc. WALLACE G. IMHOFF (Wallace G. Imhoff Co.) *Products Finishing*, Vol. 3, Jan. 1939, pp. 35-47. Research. 28-gage sheet steel was placed in a Zn bath of commercial quality used for galvanizing, heated to the desired temperature, held for 6 hrs. and cooled in the furnace. Tests were started at 800° F., with 50° F. intervals between tests up to 1100° F. Beyond 1100°, tests were made at 1300° and 1565° F. Diffusion shows a sharp increase at 900° F. In a study of the melt at 950° F., it was found that on forming, the Zn-Fe alloy dropped to the bottom, leaving the top of the melt as uncontaminated Zn. This happened only at 950° F. The mechanism of the disintegration of the Fe is explained as diffusion and solution of the Fe in the Zn bath and a precipitation of a Zn-Fe alloy, which depletes the bath of Fe and permits continued diffusion. PCR (7b)

Disintegration of the Aluminized Layer of Iron-carbon Alloys (Zerfallserscheinungen in der Alitierungsschicht auf kohlenstoffhaltigem Eisen) W. BAUKLOH & W. BÖKE. *Arch. Eisenhüttenw.*, Vol. 12, Jan. 1939, pp. 345-347. Original research. A photograph is shown of a cylinder of 2.6% C cast iron that had been aluminized by heating in Al powder. After standing in air for 4 months, the aluminized layer had completely disintegrated to powder. To help explain this, a series of Fe-C alloys, containing from 0.02 to 3.6% C, were aluminized by heating 10 hrs. at 1000° C. in a mixture of 40% Fe and 60% Al powder with the exclusion of air. Some of the specimens were then kept in a dessicator and some in the presence of moist air. In the moist air, the specimens containing less than 0.6% C were stable but those higher in C completely disintegrated after 3 days. The disintegration was attributed to the formation of an aluminum carbide, Al_4C_3. Micrographs are shown of this constituent (hexagonal crystals) as it appeared in an alloy of 66.4% Fe, 31.9% Al and 1.3% C. SE (7b)

Abrasive Finishing of Stainless Steel. BARTLETT WEST. *Products Finishing*, Vol. 3, Jan. 1939, pp. 16-18. Discussion. Grinding is accomplished with grits of 80, 120, 150, 180, 200 and 240 in successive operations using Al oxide. Buffing is done with green chrome. Red rouge or Fe-containing polishes should not be used. Speeds of 6,000-8,000 surface ft./min. for a satin or matte finish and 8,500-12,000 for a bright finish are recommended. Grinding belts are briefly considered. PCR (7b)

Definition of Terms Describing Abrasive Operations. H. J. WILLS. *Metal Ind., N. Y.*, Vol. 37, Jan. 1939, pp. 31-33. The following terms are defined: Precision grinding, semi-precision grinding, hand grinding, honing, lapping, rubbing, polishing, roughing, dry finishing, oiling, buffing, cut-down buffing, color buffing or coloring, sandblasting, tumbling, sanding and sand bobbing. CBJ (7b)

8·TESTING AND CONTROL

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

Modern Testing of Thin Sheets (Neuzeitliche Feinblechprüfung) W. PÜNGEL & H. KAYSELER. *Tech. Zentralblatt prakt. Metallbearbeit.*, Vol. 49, Jan. 1939, pp. 37-41. Original research. The testing of thin sheets in regard to their usefulness and behavior in commercial manufacturing processes involves great difficulties. The customary tensile and folding tests furnish limited information on certain features but not on the most important physical property of high-quality sheets, *i.e.* on deep drawability. For single operations, the Erichsen, Pomp-Siebel and A.E.G. tests are useful, but these methods are inadequate for materials submitted to multi-stage deep drawing processes. The Research Institute of the Vereinigte Stahl Werke has developed, for the latter purpose, a deep drawing test (*Keilzugtiefungsverfahren*) in which wedge-shaped specimens of certain dimensions are drawn through a prismatic die. At various spots of different reductions of cross sectional area of the wedge, additional Erichsen tests are performed and related to the deep-drawability of the undeformed sheet. The equipment can be easily installed in any tensile testing machine. Drawing experiments on steels and non-ferrous materials yielded excellent agreement between the results from commercial drawing processes and the new testing method, while the Erichsen test alone furnished confusing results. In addition, a new testing apparatus for the accurate determination of the bending number in reverse bending was developed. The former methods yielded greatly varying values in the case of thin sheets and strip, particularly if the latter were springy. The feature of the new apparatus is a specially guided bending roll that insures an intimate contact between the strip sample and the bending surfaces. The variations of the testing results have thus been reduced to a minimum. The 10 accompanying illustrations show the new apparatus and also the testing results on a great variety of materials. EF (T-8)

Discussion of Some Sources of Error of Quantitative Spectrographic Analysis with Special Consideration to Lead Alloys (Erörterung einiger Fehlerquellen der quantitativen Spektralanalyse unter besonderer Berücksichtigung der Bleilegierungen) O. WERNER & W. RUDOLPH. *Angew. Chem.*, Vol. 51, Dec. 24, 1938, pp. 899-906. The sources of error in the determination of small amounts of As, Sb, Bi and Te in Pb are explained in detail, test results are given and the best shape and size of the spark electrodes discussed. The surface of the electrodes is preferably 5-7 mm.^{2} The sparks should pass at least 6 min. before the analysis is made. Ha (H-8)

Widely Usable Portable Hardness Tester (Vielseitig verwendbarer Hand-Härteprüfer) *Tech. Zentralblatt prakt. Metallbearbeit.*, Vol. 48, Dec. 1938, p. 885. Descriptive. A new portable hardness tester, developed by the Focke-Wulf Aircraft Co., uses the Rockwell principle of pre- and main-loading. Brinell and Vickers hardnesses can also be determined. The instrument weighs about 2 lbs., and a beak-shaped front is screwed tightly onto the test piece. A minimum clearance of 30 mm. and width of 20 mm. is required. The manipulation of the new instrument is fully described and illustrated. EF (T-8)

The Investigation of Temperature Fields (Die Untersuchung von Temperaturfeldern) F. PENZIG. *Automobiltech. Z.*, Vol. 42, Jan. 25, 1939, pp. 38-41. Original research. For the investigation of temperature distribution in materials used in aviation and automotive engines "thermocolors" (paints that change color within definite temperature ranges) were developed. They are metal compounds that lose H_2O, CO_2, or ammonia, thus changing composition and color. Compositions are not revealed. Accuracy is $\pm 5°$ C. The time element, of course, has to be considered in their use. Synthetic resin is used as binder. Test results can be recorded in color pictures or in black and white photography by marking the different color fields with chalk. Experiments with engines are described. The method appears to be suitable for a variety of machines and material investigations. RPS (T-8)

Quantitative Spectrographic Analysis of Metals by Means of the Flame and the Spark-in-flame (Die quantitative Spektralanalyse von Metallen mittels der Flamme und des Flammenfunkens) H. LUNDEGARDH. *Metallwirtschaft*, Vol. 17, Nov. 18, 1938, pp. 1222-1226. Comprehensive review of the technique and applications of flame excitation in quantitative spectrochemical analysis. Particular emphasis is placed on the developments made during the past several years in the author's laboratory. While flame excitation is especially applicable to the analysis of solutions, it may, under certain restricted conditions, be used to analyze powders and solid samples. Contrary to the usual opinion, flame excitation is not limited to the alkalies and alkaline earths. By proper choice of experimental conditions, about 25 elements may be determined. If a condensed spark is passed through the flame, 45 elements, including many of the heavy metals, may be determined. The average sensitivity of detection is about 1 mol./l. of solution and the analytical error is 1-2%. This high accuracy is probably due to the homogeneity of the solution sample. The chief advantages of flame over spark excitation consist in the reproducibility of the light intensity by control of the gas and air pressures; the excitation of only a few lines of each element that permits the use of a spectrograph of low dispersion; the practically negligible effect of large, varying amounts of one element upon the analyses for others; the negligible effects of the anions present in the sample; and the presence of a constant background that may serve as an internal control for the analysis. The principal disadvantages are the practical requirement of putting the samples into solution and the relatively low sensitivity of detection of the heavy metals. J. S. Owens (H-8)

Emission Spectrographic Analysis in Industrial Laboratories (Emissionsspektralanalyse in Industrielaboratorien) GUNTHER BALZ. *Metallwirtschaft*, Vol. 17, Nov. 18, 1938, pp. 1226-1231. Review. The principal advantages of spectrographic methods for industrial analyses are described. The usefulness of these methods for the rapid detection, in alloys, of unexpected elements not found in routine chemical analysis is illustrated by the detection of Mn in certain Zn specimens. A number of qualitative and quantitative analyses of representative industrial materials for metallic constituents or impurities are briefly described. The qualitative examples include the analysis of gasoline, lubrication oil, diamond powder, electroplating baths, brass, Al, Ni anodes, dust, soldering paste, welding powder and dyed fabrics. The quantitative analyses include those of Al alloys, high grade Pb, pure Zn and Sb. A brief discussion is given of the value of spectral line photometry in quantitative analysis, of solution analysis methods for the determination of the composition of standard alloys and of the influence of one alloying constituent upon the analyses for others. J. S. Owens (H-8)

Etching Steel with Cathodic Hydrogen (L'attacco dell' acciaio con l'idrogeno catodico) A. BARTOCCI. *Met. Ital.*, Vol. 30, Nov. 1938, pp. 621-630. Original research. By making a test piece of steel the cathode in an electrolysis using a bath of 2-2.5% NaOH, the surface is etched in a characteristic manner. The etching is made still plainer if the electrolysis in the NaOH solution is followed by an electrolysis in dilute HNO_3 solution. Tests made on a Cr-Ni steel (1.20% Cr; 3.5% Ni + 0.35% Mn) indicate that the appearance of the etched surface is related to the resilience and other physical properties of the sample. Naturally, controls must be run for each type of steel. AWC (T-8)

Quality Control of Steel. RALPH F. BISBEE (Westinghouse Elec. & Mfg. Co.) *Iron Age*, Vol. 142, Dec. 29, 1938, pp. 20-22. Practical discussion of methods of testing all "bought-outside" material. Deep drawing steels are tested by (a) cup test to determine ductility; (b) Rockwell hardness tests and (c) elongation tests. Steels for vitreous enameling are checked as follows: (a) Bond test; (b) sag test and (c) enamel performance test. Other steels are checked in a similar manner. However, the method varies according to application. Adequate quality control prevents rather than cures, eliminates misunderstanding with suppliers, systematizes production and results in higher quality. VSP (T-8)

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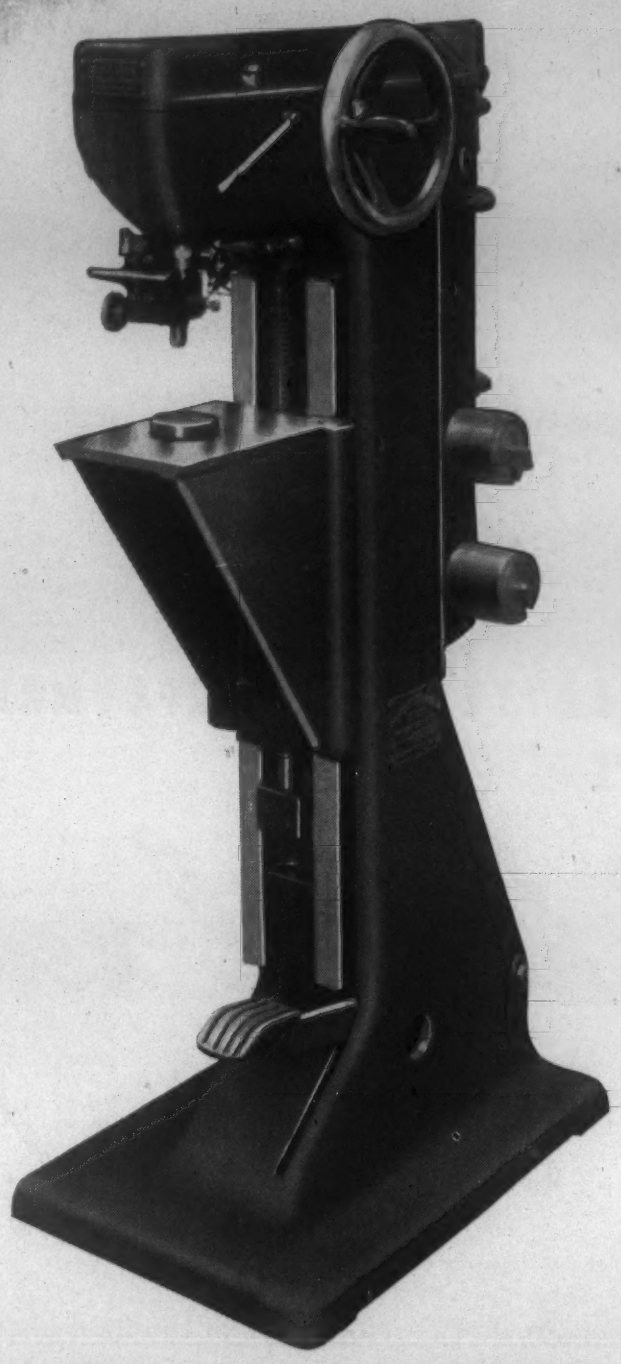

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Practice in Mechanical Testing. V. E. GREEN. *Foundry Trade J.*, Vol. 60, Feb. 2, 1939, p. 111. Review. The beam tensile-testing machine in its best and simplest form is of the single-lever type, having 2 knife edges with the straining gear hydraulically or screw-and-nut operated. With "slippery" materials, like the Mn- and Al-bronzes, carefully screwed-end test pieces are very satisfactory. The "rate of loading" is often mentioned as important by testing engineers. Investigation of various commercial rates of tensile loading of materials shows that the variation of results is chiefly due to the difficulties of reading the load on the specimens; that is, either the poise weight moves too quickly along the beam or the pointer too quickly round the dial for a precise reading at the moment of fracture of the test piece. The dial-type hydraulic machine with less inertia of moving parts may, therefore, have an advantage over others. Horizontal tensile-testing machines, the Ewing, Lindley and Huggenberger's extensometers, and different hardness-test machines are discussed. The Vickers diamond hardness-testing machine is an excellent example of a precision-testing machine. The Shore scleroscope is a useful adjunct in a general test laboratory. The calibration of hardness-testing machines presents many difficulties. It appears necessary that some series of standardized hardness test-blocks should be issued by a competent authority at a commercial rate. It is obvious that an impact figure is a useful indication of the internal character of the steel, but unfortunately the actual numerical results obtained do not directly aid the designer of machine parts in the same way as a tensile or torsion test. AIK (T-8)

Photoelasticity. Principles, Methods and Applications in Testing Materials, in Metallurgy and in Mechanics (La Photoélasticité. Principes, Méthodes et Applications aux Essais des Matériaux, à la Métallurgie et à la Mécanique) P. LAURENT & A. POPOFF. *Rev. Mét.*, Vol. 35, Aug. 1938, pp. 363-378; Sept. 1938, pp. 407-424; Oct. 1938, pp. 448-473. Discussion of mathematical theory and methods of photoelastic analysis of stress concentration. Materials used are: Celluloid (England), plexiglass (France), pollopas and trolon (Germany), bakelite and marblette (U.S.A.) and phenolite (Japan). Bakelite is more sensitive than celluloid but is also more difficult to machine. Applications given are: (1) Stress around holes, such as rivet holes; (2) effect of notches, with particular reference to notched impact specimens (maximum stress with Izod notch is 4.78 times mean stress; with Charpy keyhole notch, it is 3.34 times mean stress; with rectangular notch, stress concentration is very slight); (3) gears; (4) cutting tools to determine correct shape of tool and mechanics of actual cutting process (there is a high degree of compression in front of tool leading to rupture, which forms the chip; the chip torn out by the tool has a constant color, unless the tool has been poorly sharpened, when the chip and plastic deformation zone show periodic variations of color and extent, respectively); (5) wire drawing; (6) 3 dimensional stress analysis; (7) stress analysis of vibrating objects (by means of stroboscope). JZB (T-8)

Hairline Imperfections: The Nature of Hairlines and Methods for Their Detection in Semi-finished Steel Products. CARL L. SHAPIRO. *Iron Age*, Vol. 142, Dec. 1, 1938, pp. 32-36; Dec. 8, 1938, pp. 30-35. Practical discussion of experimental work and opinions of other authorities on the detection of hairline imperfections. Gives data on a new visual non-destructive test for detection of imperfections that consist in coating the surface of the part to be examined with special brittle and strongly adhering lacquer. The part is then stressed or vibrated. Local stress concentration cracks off the coating, and, therefore, stress concentrations are produced by surface cracks. Position of cracks due to stressing will show cracks in metal. Stress concentration of 10 to 1 will be produced in lacquer by crack in the metal. Gives table showing frequency and severity rating per hairlines and includes photograph of crack in Al propeller blade obtained by this method of testing. Defines and classifies imperfections in steel and various destructive and non-destructive tests. VSP (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Reversed Bend Fatigue Strength of Fillet and Butt Welds. A. THUM & A. ERKER. *Welding J., N. Y.*, Vol. 17, Nov. 1938, Suppl. pp. 27-28. Extended abstract of article in *Z. Ver. deut. Ing.* See *Metals and Alloys*, Vol. 10, Feb. 1939, p. MA 108 R/3. CEJ (8a)

Preparation of Rotating Beam Fatigue Specimens. A. HENDERSON & W. B. SEENS (U. S. Steel Corp.) *Metals and Alloys,* Vol. 10, Mar. 1939, pp. 82-84. Descriptive. Emphasizes the necessity for the absence of circumferential scratches or tool marks and the need of perfect concentricity in order to avoid vibrational stresses and secure uniform and reliable results from a series of tests. The precision operations described (for specimens to be tested in the R. R. Moore machine) assure that if imperfections remain, they will be in a longitudinal direction. Two special fixtures, one for radius turning, and the other for dressing the grinding wheel, are readily attached to standard machines and obviate investment in expensive special machines. For the final longitudinal polishing of the specimen, an apparatus comprising a reciprocating arm and means for rotating the specimen was developed. A center arm carries a pair of pivoted self-aligning fingers to which the felt pads are attached, traversing the entire center section of the specimen at about 250 strokes per min. 20-30 min. is required to polish, depending on the composition and hardness of the sample. This type of machine polishing produces a duplication of surface finish better than that obtained by tedious hand polishing. Details, with illustrations given. FPP (8a)

Improving Aircraft Propellers by Surface Rolling. G. SACHS. *Metals and Alloys,* Vol. 10, Jan. 1939, pp. 19-23. Descriptive. Aluminum is favored over Mg alloys for aircraft applications because the latter, although only 2/3 as heavy as Al, are subject to serious reductions in strength through corrosion and other factors. One very interesting field for Mg is in aircraft propellers, which have increased so rapidly in size that many believe Al is already too heavy. To get the full benefit of magnesium's light weight, however, special treatments, such as that described, must be applied. Without the treatment an alarming fraction of Mg propellers failed by fatigue after very short service. Analysis of the failures showed that exposure to fresh water during test reduced the fatigue strength (as determined in a rotating beam machine) 50%; fastening a stiff collar around the central portion of a specimen reduced the fatigue strength to 30% of its normal value; cylindrical specimens that break in the holder showed the same low fatigue value. Improvement was effected by using thin, flexible collars with carefully rounded edges, by interposing fibre layers or by chromate treatment, but the most marked improvement resulted from "surface rolling," which gave a product whose tested fatigue strength under the worst corrosion and erosion conditions was 90% of the normal value. Surface rolling consists in deforming the surface skin with rolls, just about as a bar is treated in a roller straightener. Pressure must be limited to avoid chipping. Equipment and procedure specially designed for propellers are described. Full-scale tests showed that surface rolling could be expected to produce an improvement of 50% in fatigue strength. FPP (8a)

The **Fatigue Strength of Wrought Aluminum Alloys** (Untersuchungen über die dauerfestigkeit von Aluminium-Knetlegierungen) EMIL VON RAJAKOVICS. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde,* 1938, pp. 74-77. With discussion. Research. Most earlier investigations on the fatigue properties of wrought Al alloys have comprised determinations of the reversed bending strength on rotating bars. Results of flat bending tests are rare, whereas investigations on the alternating tension-compression fatigue strength are also rare. The present investigations made with a Schenck alternating tension-compression machine at about 2800 cycles/min., are intended to fill this gap. The tension-compression endurance limits (samples unbroken after 50×10^6 cycles) of 4 mm. "Duralumin 681ZB 1/3" (Al-Cu-Mg) sheet, and of 3 mm. "Duranalium MG7" (Al-Mg) sheet were each about 13,500 lbs./in.^{2} At equal loads that destroyed both samples in less than 30,000 cycles, however, the Duralumin withstood a greater number of stress reversals than did the Duranalium. 1-mm. holes lowered the endurance limit of the Duralumin to 10,000 lbs./in.^{2} and 3 and 6 mm. holes to 8,000 lbs./in.^{2} The finish on all samples was ordinary rolled surface. Tests were also made, on another machine, of the fatigue (bending) strength of 5-mm. Duraluminum sheets, to study the effects of surface condition, sample width, rolling direction and holes.

GN + FPP (8a)

Endurance of Annealed Gold and a Quenched Dental Alloy. R. H. LAUDERDALE, R. L. DOWDELL & K. CASSELMAN. *Metals and Alloys,* Vol. 10, Jan. 1939, pp. 24-25. Research. The endurance limit and resistance to overstress are of some importance in the selection of dental alloys. The endurance limits in completely reversed bending of pure Au and of a quenched dental alloy were determined in a "baby" Upton-Lewis fatigue tester. The Au had been annealed at 500° F. for 30 min. and furnace-cooled; the dental alloy (6.25% Cu, 12.75% Ag, 6% Pt, and 75% Au) had been water-quenched after 30 min. at 1400° F. The endurance limits (10×10^6 cycles) were 4,500 lbs./in.^{2} for the Au and 28,450 lbs./in.^{2} for the alloy. The endurance ratio for the pure Au, 26%, is in the usual range for non-ferrous alloys; the ratio for the alloy, 40%, approaches the customary value for steel. FPP (8a)

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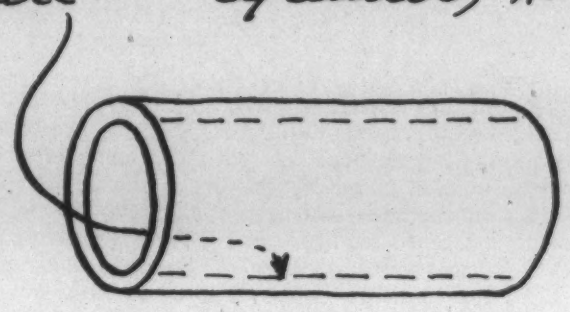

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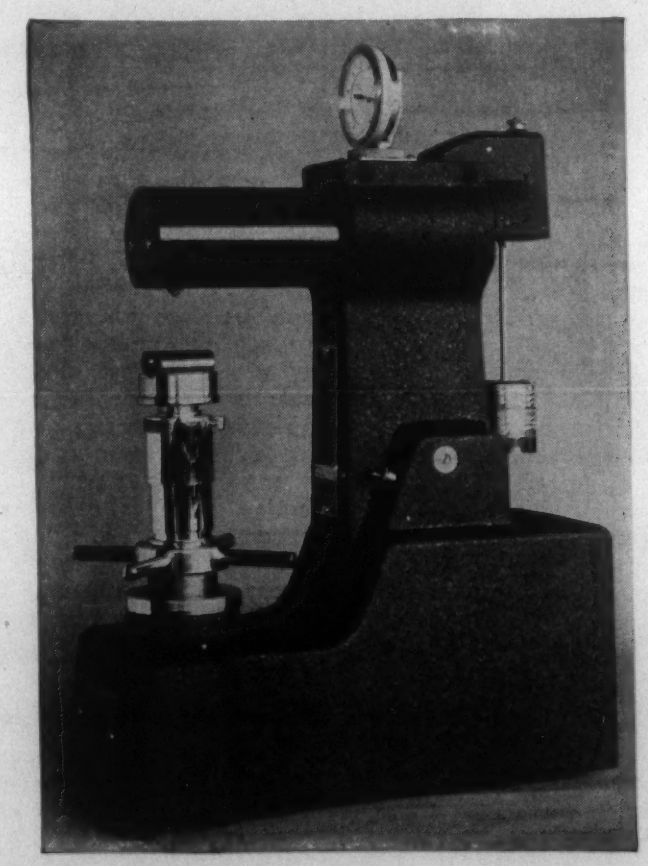

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9 · METALLOGRAPHY

Structure and Constitution. Metallographic Equipment.

J. S. MARSH, SECTION EDITOR

The Development of Metallography. H. MORROGH. *Bull. Brit. Cast Iron Research Assoc.,* Vol. 5, Nov. 1938, pp. 268-271. Historical review. Although Sorby is generally considered to be the founder of the science of metallography, it should be remembered that microscopic methods had been used previously by other investigators in metallurgical studies. In his *Micrographia* (1665) Robert Hooke drew magnified pictures of polished steel objects and in 1722 Réaumur used the microscope to examine fractured surfaces of steel and of cast Fe. Using these observations as a basis Réaumur suggested a polyhedral arrangement of crystals in metals and a theory for the hardening of steel on quenching. In 1808 Widmanstätten showed that certain meteorites, when cut, polished, and etched, develop a distinct structure. The Russian general Anossoff used a microscope to examine etched surfaces of Damascene steel blades in 1841, and a microscope was among the apparatus used by Faraday in his metallurgical researches. With this scanty background, Dr. Henry Clifton Sorby, of Sheffield, notable as the founder of petrography, devised in 1861 a suitable technique for the preparation and examination of metallic microspecimens. The subsequent contributions of Martens, Wedding, Stein, Werth, Osmond, Roberts-Austen, Rozeboom, etc., are discussed. Methods of microscopic examination of metals have greatly multiplied recently, with the introduction of the ultra-violet metallograph by Lucas, and Smiles and Wrighton, of fluorescence analysis by Mitsche, of interference-fringe technique by Chalmers and Hoare, by the elaboration of the dark-field illuminator and by development of the use of polarized light by reflection. The last method was introduced to metallography by Koenigsberger in 1909. The electron microscope, though still in the undeveloped state, will probably be of considerable use to metallographists, in view of the high resolving power obtainable and the fact that it can be used to examine metals at high temperatures. Burgess and Ploos Von Amstel, using this instrument, were able to secure a cinematographic record of alpha $\rightleftarrows$ gamma transition process. [In this otherwise excellent review, no mention is made of works of D. K. Tschernoff and of R. Mannesmann. D. K. Tschernoff ("*D. K. Tchernoff,*" by L. Dlougatch. *Rev. Métallurgie,* 1915, pp. 832-839) advanced around 1868 the theory of the structural transformations in steel on heating and cooling. The temperatures at which these transformations occur he indicated by letters a, b and c. These critical points of Tschernoff may be regarded as a beginning of the heat-treatment theory. Richard Mannesmann ("Studien über den Zementstalprozess" *Verhandlungen des Vereins zur Beförderung des Gewerbfleisses,* Vol. 58, 31-68, 1879; see also: "The Status of the Double Iron-Carbon Diagram," by A. I. Krynitsky. *Metals and Alloys,* Vol. 1, pp. 465-469, 1929-1930), presented the first iron carbon diagram in 1879.—A.I.K.]

AIK (9)

The Nature of the Interatomic Forces in Metals. LINUS PAULING (Calif. Inst. Tech.) *Phys. Rev.,* Vol. 54, Dec. 1, 1938, pp. 899-904. Original research and theoretical discourse. It has been assumed that in the transition elements Fe, Co, Ni, Cu, etc., the third shell is filled with 10 electrons or is nearly filled, and that the *d* electrons make no significant contribution to the cohesive forces in metals. Evidence is presented to show that about half of the *d* orbitals (2.56 of the total of 5) are involved in bond formation, through hybridization with the 4*s* and 4*p* orbitals, and that the number of covalent bonds resonating among the available interatomic positions increases from 1 to nearly 6 in the sequence K, Ca, Sc, Ti, V, Cr, remains nearly constant from Cr to Ni, and begins to decrease with Cu. The remaining 2.44 *d* orbitals, with very small interatomic overlapping, are occupied by non-bonding electrons which are mainly responsible for the ferro-magnetic and paramagnetic properties of the metals. This point of view provides a qualitative explanation of many properties of the transition metals (including those of the Pd and Pt groups), such as interatomic distance, characteristic temperature, hardness, compressibility, and coefficient of thermal expansion, and it accounts satisfactorily for the observed values of the atomic saturation magnetic moments of the ferromagnetic elements Fe, Co, Ni, and their alloys. It is also shown to provide a reason for the occurrence of the positive exchange integrals that give rise to ferromagnetism.

WAT (9)

9a. Ferrous

J. S. MARSH, SECTION EDITOR

The Influence of the Original Cast Structure on the Properties of Hot-worked Steel. K. KORNFELD. *Hutnik,* Vol. 10, No. 6, 1938, pp. 320-329. In Polish. Original research. A 240 x 240 mm. steel casting containing 0.3-0.32% C, 1.05-1.2% Cr, 4.6-4.65% Ni, 0.55-0.6% Mn, 0.28% Si and 0.18% Mo was forged into an 80 x 80 mm. piece. This was normalized after heating to 850° C., annealed for 3 hrs. at 650° C., cooled to 300° C. in the course of 18 hr., then cooled in the air; the sample was then cut into 25 equal parts and re-annealed at 650° C. Microscopic examination showed that Ni-Cr-Mo steel possesses, even after the above treatment, fragments of the original structure. At the edge, where masses of dendritic aggregates were observed, the steel showed markedly diminished resistance to crushing, and a somewhat increased tensile strength and yield point. The elongation is not affected by the macrostructure. The grain size of the original austenite has no relation to the differences in the properties. The forging operation itself had no effect on improvement of the mechanical properties. The cast structure greatly influences the final properties of the steel; a coarse original structure may lower the resistance to crushing. The center zone of the ingot possesses better resistance to crushing and insignificantly lowered yield point and tensile strength.

JGT (9a)

X-ray Investigation of the Crystal Structure of Graphite from Gray Iron and Malleable Iron (Röntgenographische Untersuchungen über die Feinstruktur von Graphit aus Grauguss und von Temperkohle) JOHANN AUGUST LAU. *Forschungsarb. Metallkunde Röntgenmetallog.,* No. 22, 1937, 36 pp. Original research. The formation of graphite and temper C is discussed in light of the previous literature. For an X-ray study, C was obtained from gray Fe, from mottled Fe containing the so-called eutectic containing graphite, and from malleable Fe. The C was obtained by dissolution of the metallic phase in dilute HNO_3 and by mechanical separation from filings. The C from all materials obtained by chemical separation had a structure identical with that of commercial graphite. With the C obtained by mechanical separation, the structures differed slightly from that of commercial graphite, and the structure of graphite from gray Fe differed from that of graphite from malleable Fe and the graphite forming the so-called eutectic. The difference in the structures were indicated by the absence of certain lines observed in the commercial graphite. The slight differences in structure were attributed to the solution of Fe in graphite.

JLG (9a)

Magnetic Torque Studies of the Texture of Cold-rolled and Recrystallized Iron-silicon Alloys. LEO P. TARASOV (Gen. Elec. Co.) *Metals Tech.,* Vol. 6, Jan. 1939, 19 pp. Original research. Magnetic torque studies were made and an attempt to correlate the results with pole figures representing orientation. Tests were made on disks of both cold rolled and recrystallized Si steel sheet. In a few instances the correlation between pole figures and torque was good, but in most cases there was much to be desired. A contributing factor to the poor correlation may be the unsatisfactory manner in which pole figures represent the real orientation. Torque studies should prove valuable in determining the most interesting structures that should be studied with X-rays.

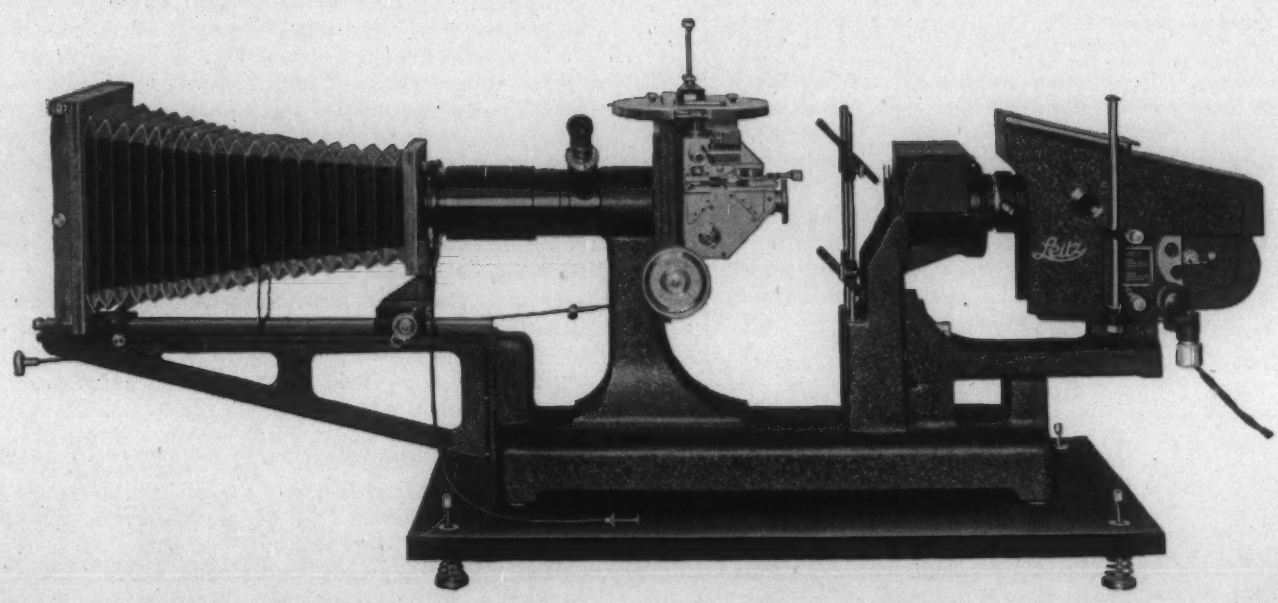
JLG (9a)

The System Iron-nickel-nickel Titanide Ni_3Ti-iron Titanide Fe_2Ti (Das System Eisen-Nickel-Nickeltitanid Ni_3Ti-Eisentitanid Fe_2Ti) R. VOGEL & J. WALLBAUM. *Arch. Eisenhüttenw.,* Vol. 12, Dec. 1938, pp. 299-304. Diagrams are shown for the binary system Ni-Ni_3Ti, and for sections through the Fe-Ni-Ti diagram up to 30% Ti. A ternary diagram for the system Fe-Ni-Ni_3Ti-Fe_2Ti is then given.

SE (9a)

Leitz

MICRO-METALLOGRAPH "MM-2"



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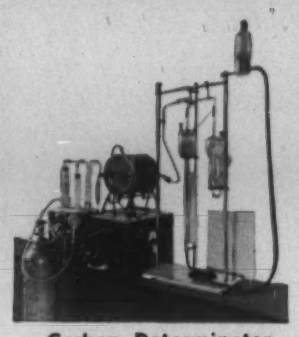

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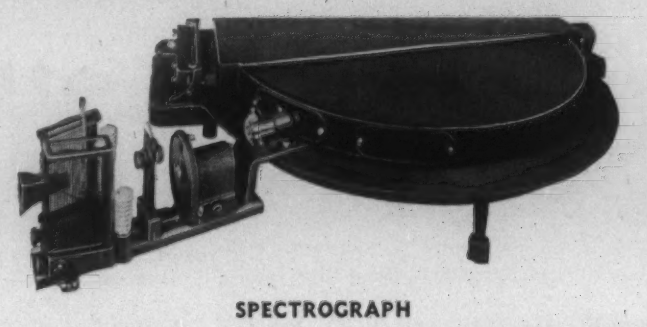

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Formation of Eutectic and Eutectoid Graphite in Gray Cast Iron (Ausbildung des Segregatgraphits und des Graphiteutectoids im grauen Gusseisen) H. HANEMANN & A. SCHRADER. *Arch. Eisenhüttenw.*, Vol. 12, Nov. 1938, pp. 257-259. Original research. The view that on solidification of gray cast Fe graphite forms only as a result of the breakdown of cementite has been shown by Tangerding to be untenable. Graphite may form directly not only from the melt but also from the γ solid solution. Such graphite either joins previously-formed graphite or forms separate graphite crystallites. Sometimes, however, it forms thin plates in a Widmanstätten structure. The graphite eutectoid, which then appears on cooling through A_1, is more or less structureless and does not show any uniform alternate layers of graphite and ferrite lamellae. In most instances, however, the graphite coalesces with previously formed flakes, and this in turn creates rather large ferrite islands. SE (9a)

Iron-carbon Diagram in Polar Co-ordinates. G. O. MARRS. *Steel*, Vol. 103, Oct. 10, 1938, p. 91. Outstanding features claimed for the diagram are: Higher temperature part is accented, spread out, and made available for easy and efficient study; by giving radii spacing an empirical value of 0.85% C, eutectoid, eutectic, steel-Fe boundary, and the all-cementite line terminal fall on main divisional radii and the whole figure comes into a natural division of important parts; polar diagram is alleged to be the more instructive. MS (9a)

9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

Copper-rich Nickel-aluminum-copper Alloys. Part II.—The Constitution of the Copper-nickel-rich Alloys. W. O. ALEXANDER. *J. Inst. Metals*, Vol. 63, 1938, Advance Copy No. 815, 21 pp. Original research. A series of Al-Cu-Ni alloys containing from 1 to 35% Al was made, and the phase changes which these ternary alloys undergo on heat treating were studied by thermal analysis, and by microscopic and X-ray methods. The phase relations at the solidus and at elevated temperatures were found to be: (1) Primary separation of the compound NiAl containing Cu in solid solution; (2) NiAl is isomorphous with the β phase (Cu_3Al) at elevated temperatures, but immiscibility occurs below 750° C.; (3) a eutectic valley runs from the Ni-Al to the Cu-Al binary alloys, the liquid initially separating $\alpha + \Theta$ (Ni_3Al) and, below 1260° C., α + NiAl (isomorphous with β). Thus, at low temperatures, 2 phases of the Ni-Al binary system, namely the compounds NiAl and Θ (Ni_3Al), are shown to take some Cu in solid solution, and in these forms, *i.e.*, as NiAl solid solution and Θ (Ni_3Al) solid solution, to extend their phase-formation influence right into the Cu corner of the diagram to compositions of the order of only 3% Ni with 3 and 1% Al, respectively. For Part I, see *Metals and Alloys*, Vol. 8, Dec. 1937, p. MA 764 L/1. JLG (9b)

The Two Liquid Layers in Cu-Fe Alloys. K. IWASE, T. AMEMIYA & M. OKAMOTO. *Nippon Kinzoku Gakkai-Si*, Vol. 2, Dec. 1938, pp. 584-592. In Japanese. Original research. The supposed immiscibility in liquid Cu-Fe alloys was reinvestigated by determining the liquidus and equilibrium of these alloys at 1450° C. and 1540° C., paying special attention to the effects of a very small amount of C in the alloys. Since no particular point on the liquidus curve of pure Cu-Fe alloys was found, no monotectic reaction is likely to occur. An addition of 1% of either Al, Ni, Pb, Sn or Zn in Cu-Fe alloys (50-49) did not separate the liquid into 2 layers. In the C-Cu-Fe alloys, 2 liquids co-exist in equilibrium at 1450° C. and 1540° C., and each heterogeneous zone lies very near the side corresponding to the binary system consisting of Fe and Cu, but it does not cut that side, having a definite clearance, about 0.02-0.03% C content, between the zone and the side. Therefore, with alloys that are C-free, or have a C content less than 0.02-0.03%, the liquid does not separate into 2 layers up to 1540° C. The amount of C necessary to cause the separation varies with the Fe content of the alloy; the more Fe, the greater is the amount of C necessary for separation. The temperature coefficient of the mutual solubility of the conjugates was positive. NS (9b)

Several Cd-Cu-Zn Alloys High in Cd Content (Su alcune leghe cadmio-rame-zinco ad alto contenuto di cadmio) G. G. MONSELISE. *Chimica e Industria (Italy)*, Vol. 20, Sept. 1938, pp. 594-596. Original research. Jenkins (*J. Inst. Metals*, Vol. 36, 1926, p. 68) has investigated the Cd-Cu-Zn system up to 15% Cd and up to 50% Cu and Zn. The present author considers systems high in Cd, with low Cu (up to 10%) and up to 50% Zn. The diagram shows the presence of a ternary eutectoid melting at 258° C., formed by the convergence of 3 binary eutectics derived: (1) from Cd containing 0.1% Cd_3Cu in solid solution, and Cd_3Cu containing up to 2% Cd in solid solution, melting at 314° C. and containing 1.25% Cu; (2) the binary eutectic between solid solutions of 2.15% Cd in Zn and of 2.95% Zn in Cd, melting at 266° C. and containing 17.40% Zn; (3) a ternary zone rich in Zn, probably derived by a transformation of solid solutions of Zn-Cu. AWC (9b)

The Alpha Solid Solution Limit of Copper-zinc and Silver-zinc Alloys (Die α-Mischkristallgrenze in Kupfer-Zink- und Silber-Zink-Legierungen) C. HAASE & F. PAWLEK. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde,* 1938, pp. 57-60. Research. X-ray determinations of lattice parameters and tests of electrical conductivity were employed. Since reactions in the solid state—and particularly precipitation occurrences—are accelerated by cold work, the latter was used to establish the equilibrium states in the field of low diffusion velocity. With brass, the α limit proceeds up to 450° C. at 38.5% Cu, but decreases to 34% Cu at 200° C. In the Ag-Zn system, the transformations are complex. Down to 200° C. the ξ phase is stable; between 200° and 150° C., a transformation takes place in alloys with more than 20% Zn, effecting a shifting of the α limit from 27% to 21% Zn. The electrical conductivity is increased considerably by this transformation. GN (9b)

The Constitution of the Cu-rich Alloys of Cu-Al-Fe System. H. NISIMURA & C. HISATUNE. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Dec. 1938, pp. 597-604. In Japanese. Original research. The constitution of Cu-rich, Cu-Al-Fe alloys containing up to 20% Al and about 10% Fe was established. A ternary phase (T), formed by a peritectic reaction, $L + \gamma_{Fe} \rightleftarrows T$, was found. This new phase dissolves considerable Fe and Al, the homogeneous field extending from 20 to 27% Al and from 25 to 45% Fe at room temperature. The following invariant reactions were found to exist on solidification and in the solid state. $L + T \rightleftarrows \beta + \gamma_{Fe}$, 1048° C.; $L + \gamma_{Fe} \rightleftarrows \alpha + \beta$, 1046° C.; $L + \beta \rightleftarrows \gamma_1 + T$, 1015° C.; $\beta + \alpha_{Fe} \rightleftarrows \alpha + T$, 750° C.; $\alpha + \gamma_{Fe} \rightleftarrows \beta + \chi_{Fe}$, about 950° C.; $\beta \rightleftarrows \alpha + \gamma_2 + T$, 560° C. The last ternary eutectoid reaction occurs at a temperature approximately 20° C. below that of the Cu-Al binary eutectoid. The γ_2 phase of the Cu-Al system has a solid solution range, the maximum solubility of Fe being about 2% at room temperature. NS (9b)

Drying Etched Lead Surfaces. DONALD L. WOERNLEY (Buffalo Niagara Elec. Corp.) *Ind. Eng. Chem., Anal. Ed.,* Vol. 11, Feb. 1939, p. 120. Helpful technique that may have further applications. A method is described for preventing air-oxidation of Pb (cable sheathing) in microtome section-size, by immersion, after etching, in acetone, and evaporating the acetone by suction. Pb surfaces that are dried according to this technique will remain free from oxide film for days. MEH (9b)

Phase Relations and Magnetic Behavior in the Chromium-selenium System. Magnetochemical Studies No. 30 (Phasen verhältnisse und magnetisches Verhalten im System Chrom/Selen. Magnetochemische Untersuchungen XXX) H. HARALDSEN & F. MEHMED. *Z. anorg. allgem. Chem.,* Vol. 239, Nov. 8, 1938, pp. 369-394. Research. X-ray and magnetic studies on the Cr-Se system showed the existence of 3 phases in the range of 50-60 atomic % Se. The homogeneity ranges of these phases are: α-phase, 50-53 atomic % Se, β-phase, about 54.5 to about 57-48 atomic % Se and the γ-phase, 59-60 atomic % Se. The intermediate ranges are 2-phase regions. The α-phase has a hexagonal B-8 structure, the β-phase a low symmetry structure possibly monoclinic and probably arising from the hexagonal structure by a slight deformation, and the γ-phase is hexagonal and related to the α-phase (B-8 structure with empty places in the Cr lattice). The magnetic characteristics of the Cr-Se alloys show an extensive approximation to ionic magnetism. Between 57.85 and 58.85 atomic % Se even the simple Curie law holds true. For the remaining concentrations the Curie-Weiss law is generally satisfied; negative θ-values are found throughout, which only in a few cases reach any appreciable numerical value. The structures and probably also the phase relationships in the systems Cr-S, Cr-Se and Cr-Te are completely analogous. HFK (9b)

The Ternary Alloys of Magnesium and Cadmium and the Binary Magnesium-cadmium Diagram I (Ueber Magnesium-Kadmium-haltige ternare Legierungen, und das Zustandsbild der binaren Magnesium-Kadmium-Legierungen I) E. JÄNECKE, L. NEUNDEUBEL & K. RUMPF. *Z. Metallkunde,* Vol. 30, Nov. 1938, pp. 390-395. Experimental. Owing to the high volatility of its components, the Mg-Cd system was studied indirectly through the ternary Pb-Mg-Cd system. Thermal analysis showed that the $PbMg_2$ phase occupied the bulk of the diagram, the entire Pb-Cd side of which is bounded by the solid solutions of these 2 metals. These 3 phases form a ternary eutectic at 194° C. and 62 atom. % Pb, 23% Cd, 15% Mg. Along the Mg-Cd side, 4 invariant points were found: M at 435° C. and 10% Pb, 71% Mg, 19% Cd; N at 386° C. and 6% Pb, 51% Mg, 43% Cd; O at 321° C. and 5% Pb, 28% Mg, 67% Cd; P at 287° C. and 8% Pb, 15% Mg, 77% Cd. It is reasoned that, by analogy, similar phases must appear in the Mg-Cd system. GD (9b)

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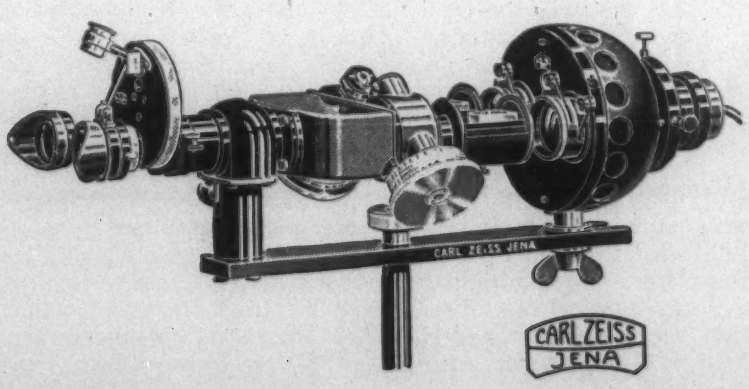

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10 · PROPERTIES AND APPLICATIONS

Including Relation of Properties to Engineering or Product Design. See also Sections 8a and 11.

M. GENSAMER, SECTION EDITOR

Properties and Metallurgical Uses of Calcium—a Correlated Abstract. C. L. MANTELL & CHAS. HARDY. *Metals and Alloys,* Vol. 10, Feb. 1939, pp. 52-56; Mar. 1939, pp. 96-100. Review. The physical and chemical properties of Ca are tabulated and discussed, its production described, and its applications examined. Ca is produced by the electrolysis of fused $CaCl_2$ or by distillation of Ca from compounds like the silicide. Recent years have seen a great improvement in the soundness of metallic Ca on the market. Commercial Ca metal contains "small quantities" of C and the alkaline and other alkaline earth metals. Ca is used industrially as a dehydrator of organic liquids, a "getter" for degassing vacua, a debismuthizer of Pb, as a carburizer and desulphurizer for iron and steel, a deoxidizer for several metals and alloys, and an alloying agent in Ni-Cr resistance alloys, bronzes, lead and its alloys for cable sheath or storage batteries, Al alloys, etc. Ca hydride is the basis of several processes for making high-grade Cu or Ni alloys of oxidizable metals, like Ti, Zr, Th and O. Ca silicide or pure Ca added to liquid cast iron aids in controlling the amount and coarseness of graphite and results in a cast iron with better mechanical properties than ordinarily. Ca additions are cited as being the major cause of the tremendous improvement in operating durability of Ni-Cr alloy heating elements. FPP (10)

Metals and Alloys in Aerial Cameras. EDWIN F. CONE (Staff) *Metals and Alloys,* Vol. 10, Feb. 1939, pp. 34-41. Descriptive. With the exception of the lens, the Fairchild aerial camera consists entirely of metals or alloys, because the cameras must be light, and at the same time rigid and permanent. Al alloys predominate in the "general purpose" camera—some as die castings, others as heat treated sheet—and are found in all parts of the camera, *viz.* the magazine, the camera body, the lens cone, the lens shutter assembly. Stainless steel, Be-Cu and Cr-V tool steel are also used for certain parts. The "special purpose" camera, used principally for military reconnaissance and extremely high altitude work in general, takes pictures 9 x 18 in. with a lens of 24-in. focal length. Because extreme lightness is vital here, the predominant metal is Mg, Dowmetal or Bohnalite X5 sand castings being used for frame or side plates and for other parts. The Fairchild company employs careful metallurgical control in its manufacturing operations, which include careful selection and inspection of materials, complete heat treating facilities, comprehensive electroplating units and an extensive machine shop. FPP (10)

A Theoretical Electron Model of the Supraconductor (Ueber ein elektronentheoretisches Modell des Supraleiters) HEINRICH WELKER. *Z. tech. Physik,* Vol. 19, Dec. 1938, pp. 606-611. Theoretical. Adopting the hypothesis of free electrons, the author proposes the following model of the supraconductor, supplementing London's theory: Defining the basic state of the metal as that state in which the electrons are at the absolute zero and without an external field, it is postulated that, in contradistinction to the normal conductor, in the supraconductor an energy of the order of magnitude of at least $A = k.T_c$ is required to raise an electron from this basic state. With this assumption, numerous experimental observations on supraconductors can be theoretically accounted for, *e.g.* the complete diamagnetism, the vanishing of the linear electronic heat, and transition curve as a limiting case of a phase transformation of the first order, and, in part, the infinite conductivity. It becomes possible to estimate the magnetic threshold value H_c for $T = O$ as it can be expressed in terms of T_c. ORS (10)

Relationship between the Mechanical Properties and Results in Service. L. W. SCHUSTER. *Metallurgia,* Vol. 19, Nov. 1938, pp. 25-28; Dec. 1938, pp. 51-54; Jan. 1939, pp. 91-96. Descriptive. The ordinary mechanical tests do not indicate how material will behave in service. When failure does occur in service, there is rarely any elongation, and the type of failure is therefore entirely different from that of a tensile test. The rate of propagation of cracks, as may be determined by Izod tests and fatigue tests on notched specimens, may give useful indications of service behavior. Many examples of failed parts are shown, practically all of which failed by fatigue. JLG (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

Alloy Steel Valves for Subzero Temperatures. GEORGE F. SCHERER (Merco Nordstrom Valve Co.) *Ind. Eng. Chem.,* Vol. 30, Nov. 1938, pp. 1220-1222. Practical. Reports on steels for valves operating at temperatures as low as —150° F. and at pressures as high as 600 lbs./in.^{2} where shock resistance is the quality most desired without sacrificing other properties. In dewaxing operations (temperatures —50° to +75° F.; pressures up to 300 lbs./in.^{2}) a suitable cast steel for valves is one containing 3% Ni, 0.25% C, 0.045% P, 0.045% S, quenched in air from 1725° F., and then from 1550° F., and tempered at 1200° F. After such treatment, the steel has a Charpy impact value of 19.4 ft.-lbs. at —50° F. Studs, bolts or forged parts for dewaxing units are made of S.A.E. 4140 steel (1% Cr, 0.25% Mo, 0.40% C) oil-quenched from 1475° F. and tempered at 1260° F. The Charpy impact value of this steel is 39.8 ft.-lbs. at —50° F. In the manufacture of ethyl chloride, temperatures as low as —150° F. and pressures up to 600 lbs./in.^{2} are successfully met by valves made of a cast steel containing 4% Ni, 0.16% V, 0.50% Mo and 0.08% C, normalized, then oil-quenched from 1550° F. and tempered at 1250° F. At —150° F. this steel has a Charpy value of 20.6 ft.-lbs. The S.A.E. 4140 steel, oil quenched from 1575° F. and tempered at 1275° F. to give a Charpy value of 18.3 ft.-lbs. at —150° F., is used for studs, bolts, etc. in the ethyl chloride valves. MEH + FPP (10a)

Effect of W, Mo and V on the Physical Properties of Ni-Cr Steel and Stainless Steel. TARIO KIKUTA & TAKESHI AKUTAGAWA. *Tetsu-to-Hagane,* Vol. 24, May 25, 1938, pp. 440-450. In Japanese. The effect of W, Mo and V on the transformation points and mechanical properties of several kinds of Ni-Cr structural steel, and of stainless steel was studied by the thermal dilatation method and hardness, tension and impact tests. With the Ni-Cr steel, Mo is the most powerful element in lowering the Ar_1 point, followed by W; the effect of V is feeble. The effect of these elements on the tensile strength of the Ni-Cr steel tempered at temperatures as low as 300° C. after quenching, is inappreciable while the effect on quenched steels tempered at 500°-600° C. is remarkable; V is most effective and W is rather feeble. In the case of 18:8 stainless steel, tensile strength is increased by adding W, Mo and V; in 13%-Cr stainless, the effect of either of these elements on the physical properties is slight. TS (10a)

A New Unit for Distillation of Crude Petroleum at Anvers-Kiel (Une Nouvelle Unité de Distillation de Petrole Brut à Anvers-Kiel) *Ossature Métallique,* Vol. 9, Dec. 1938, pp. 509-511. Practical. All flanges for manholes, pipe connections, etc. of the fractionating towers and other units are made from open-hearth steel with 0.3-0.5% Cu. This material was chosen in order to obtain the necessary thickness and thereby sufficient tightness of the joints and to allow end-to-end welding of the sheets of the columns. The condensers are likewise made from Cu-open-hearth steel. All these parts were arc welded. The tubes were made either from Cr-Mo-steel or from Cu-Mo-steel, depending upon their function in the installation. Some of these parts are working under pressures up to 40 lbs. and temperatures up to 300° C. The valve equipment is made of electric furnace steel resistant to pressures up to 50 lbs. and temperatures to 400° C. Tubes running free are suspended in high-strength Ni-Cr cast supports; Cr-Mo-steel is used for the tubes and junction boxes. RPS (10a)

Disk Damping Magnets for Electric Energy Meters in the Newer Permanent Magnet Alloys. D. A. OLWER & J. W. SHEDDEN. *J. Sci. Instruments,* Vol. 15, June 1938, pp. 193-200. Original research. Experimental data are advanced to show that newer permanent magnet alloys, of which British "Alnico" (Ni 18%, Al 10%, Co 12%, Cu 6%, Fe 54%) is representative, can be applied with real advantage as braking magnets in electrical energy meters; they are superior magnetically. Unprotected Alnico magnets were less susceptible to corrosion than fully plated and lacquered W and Cr steel magnets. RAW (10a)

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Standardization of Stainless Alloys. L. S. BERGEN (Crucible Steel Co.) *Heat Treating Forging,* Vol. 24, Dec. 1938, pp. 609-611. Survey. Presents recommendations of a group of metallurgists relative to clarification and simplification of stainless-steel types. The general purpose 18-8 Cr-Ni corrosion-resisting steels are divided into 4 groups, to replace the present 7 types: (1) High-C with combined Cr-Ni content of 27% maximum; (2) high-C with combined Cr-Ni content of 30% maximum; (3) low-C with combined Cr-Ni content of 30% maximum; and (4) low-C with combined Cr-Ni content of 34% maximum. Means should be provided for allowing addition of Cb or Ti to any of the low-C basic types, although one basic type should be considered the one to which Cb or Ti is generally added. Free-machining type should remain as now established, with only a slight modification in Cr content. Scale-resisting Cr-Ni steels possessing high strength at elevated temperatures should be retained within present general categories of 18% Cr, 8% Ni, 3% Si; 25% Cr, 12% Ni, with or without high Si; 25% Cr, 20% Ni, 1.50% maximum Si; 20% Cr, 25% Ni, with or without high Si; 27% Cr, 25% Ni; and 15% Cr, 35% Ni. Special corrosion-resisting steels, particularly those resistant to reducing acids, should also be retained. This list includes steels with 22% Cr, 8% Ni; 18-8 with 2-4% Mo; and 27% Cr, 3% Ni, and 1.5% Mo. Steel with 14% Cr, 14% Ni and 3% W should be eliminated. Investigation is being made as to the possibility of eliminating steel with 29% Cr and 9% Ni, and 18-8 steel with 1.5% Cu and 1.5% Mo. Of the essentially straight-Cr steels, the hardenable pearlitic steels should be retained essentially in their present form, except that C should be increased to 0.15% maximum to allow slightly greater hardenability and strength. Where upper Cr content in the past was 13.5%, it should be changed to 14% maximum. Modified types such as those containing Al, S, Se, W and a small amount of Ni should also be retained. Stainless cutlery and ball-bearing types containing 12-18% Cr and 0.30-1% C, with or without Mo or Co, should be kept in their present form. Ferritic steels containing 14-30% Cr with 0.35% maximum C should not be changed, with the exception of the type containing 17% Cr, 1% Si and 1% Cu, which should be eliminated, as the straight 17% Cr type can be used in its place. In lower part of Cr range, it may be necessary to have C somewhat lower—about 0.15% maximum. Semi-corrosion-resisting steels containing about 5% Cr with or without Mo and W should be retained. Effective standards with regard to No. 2 and 3 finishes on sheets and strip are practically non-existent. Recommends that on No. 2 finish no mechanical surface treatment be applied after last anneal and pickle preceding final cold pass. No. 3 and other so-called intermediate finishes should be eliminated immediately. Sheets with a No. 4, 6 and 7 finish should be furnished with a slight grind on the back not to exceed 100 grit with no attempt to remove pits. MS (10a)

The Origin of the Yield Point Phenomena of Soft Steel. MASAWO KURODA. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, pp. 1528-1633. In English. Extensive, original research. Part I (77 pages) presents experimental evidence, while Part II deals with theoretical aspects. 325 illustrations accompany the paper. The stress-strain curve of soft steel shows, immediately after the elastic limit, a horizontal part, the so-called *"palier,"* while "Lüders lines" cover the surface of the test piece. Both effects are due to the same cause. As the testing temperature rises, another group of discontinuities appears on the curve after the *palier,* and parallel lines appear on the test piece surface. These bands (Group III) are different from Lüders lines and are called "shear lines." Between the yield point and ultimate stress, a mixture of Group I and III is present (Group II). Shear lines are narrow, directed obliquely to the direction of stress and do not appear continuously side by side as do Lüders lines. Groups I and II become very pronounced with rising testing temperature, reach the maximum at 250° C. (blue shortness range) and then fade away. At about 300° C. the stress-strain curve is quite similar to that of ordinary ductile metals and alloys. In steel that does not have the pearlitic structure, quenching obliterates the yield-point phenomena, at least while the steel is in the quench-hardened condition. Tempering restores yield-point phenomena in proportion to the tempering temperature. As the grain size increases, the yield-point phenomena decay. They are also absent in steel cold-worked into a fibrous structure. In steel hardened by tension, the yield-point phenomena disappear, but aging 1 hr. at 100° C. restores them even though the steel becomes hardened. Aging cannot restore the yield-point phenomena in cold-rolled steel. The phenomena are absent in pure Fe and Cu even at very low temperatures. In alloys that easily age-harden, there appear discontinuities of Group III and shear lines. The *palier* is found in non-ferrous alloys whose structure resembles soft steel. The phenomena are interpreted on the basis of a "honey-comb structure" composed of ferrite and boundary material, the latter comprising boundary cementite, Fe nitride, strained layer of crystal lattice and impurities. Under external forces, the maximum strength of the boundary material is exceeded and the whole force is thrown upon the ferrite. An apparent elongation under constant load occurs (*palier* of the yield-point). The Lüders lines are indicative of the breakdown of the boundary structure. Model experiments demonstrate the feasibility of the honeycomb structure hypothesis. EF (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Nickel Alloy Sections and Tubes. A. B. GRAHAM. *Metal Ind., London,* Vol. 54, Jan. 20, 1939, pp. 111-114. Review of applications of Ni alloys in marine engineering. The most recent development for turbine blades is the manufacture of integral root blades by special extrusion and subsequent cold swaging process. Monel resists all but the most severe forms of blade erosion. For impulse rows in turbines, 30% Ni steel blades are used. "K" Monel offers a positive solution for erosion problems. Early Cu-Ni condenser tubes were 80-15 and 80-20 alloys, but recently an improved 70-30 alloy has been developed for this purpose. The Ni present is particularly effective in assisting in the formation of a protective film on the surface and in promoting healing of the film when damaged. Increasing the Ni to higher than 30% has shown no advantage. Methods of drawing tubes have been improved and a "tube reducing machine" evolved. The tube stock to be reduced is slid over a tapered mandrel and rod. At the end farthest from the roll housing it is clamped in a collet, which is free to rotate, and after each traverse of the roll caliber, a partial rotation of tube and mandrel is made as a new surface is presented to operate on. As the swaging operation proceeds, the tube stock is fed slowly. This machine handles 70% reduction per pass as against 20-25 for draw benches, no pointing is required, the number of annealings are reduced, the labor cost is halved and the tendency for scoring during drawing is eliminated. RWB (10b)

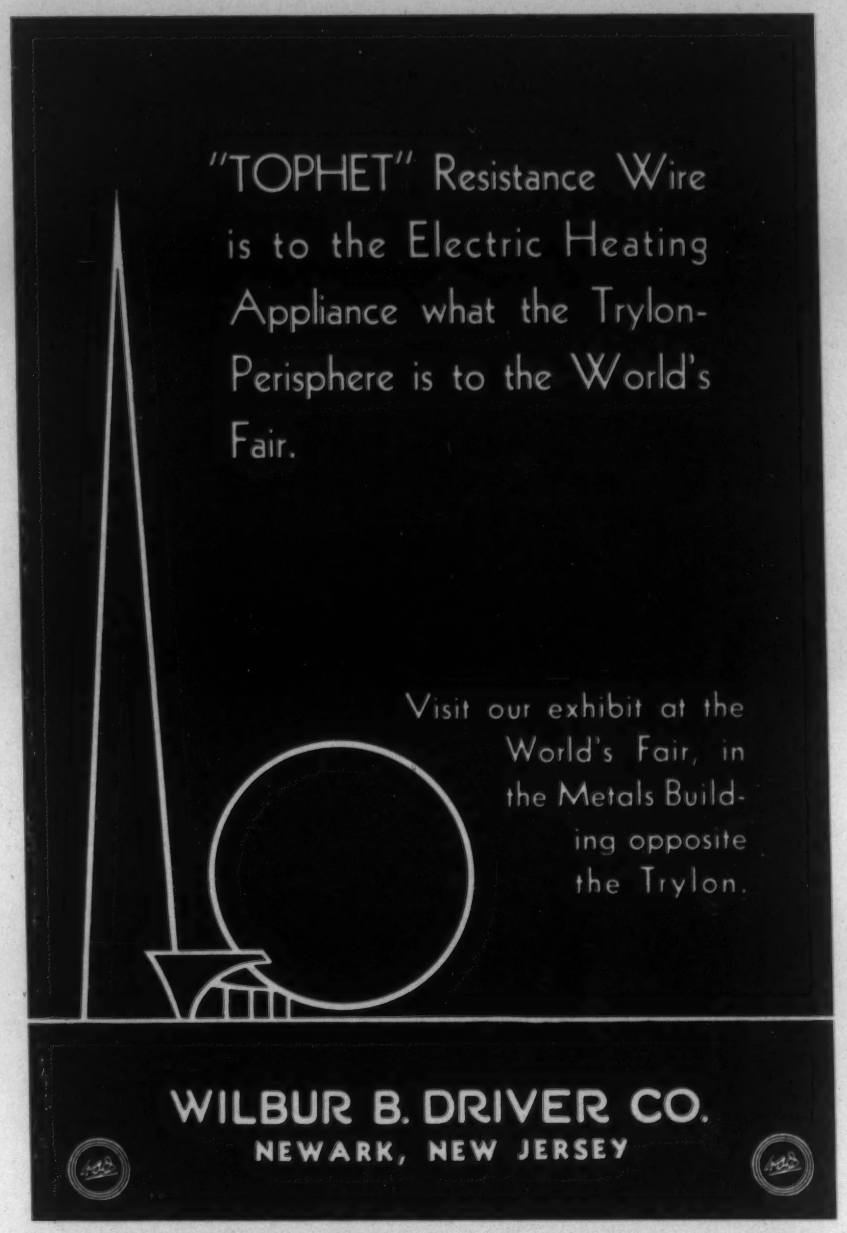
The Possibilities of Silver-rich Alloys as Bearing Materials. R. W. DAYTON (Battelle Mem. Inst.) *Metals and Alloys,* Vol. 9, Dec. 1938, pp. 323-328. Investigation of physical properties of Ag-rich alloys containing minor percentages of Pb, Sn, Cu, and 15 other elements as alloying possibilities. A diagrammatic and pictorial view and complete mechanical description of the Amsler Friction Tester as applied to bearing testing of Ag-rich alloys is given. Six tables of the results obtained show the superior qualities of pure Ag bearings. The 2 objections found against pure Ag bearings are the comparatively high cost of the metal and the fact that pure Ag possesses the property of lack of oiliness. By oiliness is meant the tendency of certain parts of the oil to adhere strongly to the metal and prevent metal-to-metal contact. This oiliness is not a function of the lubricant alone but rather of the lubricant, bearing metal and shaft. Seizure of such a bearing constructed of a Ag-rich alloy can be overcome by the addition of Pb, S and other elements. Six photomicrographs of Ag-rich alloys are given as well as a discussion by George A. Zink, Allison Eng. Co., Indianapolis, Ind. CWH (10b)

The Complex Alloys of Mg based on the Mg-Cd System (II). ICHIJI OBINATA & SHIGEHISA HAYASHI. *Tetsu-to-Hagane,* Vol. 24, Jan. 25, 1938, pp. 34-42. In Japanese. Original research. To Mg metal and to a Mg-Cd alloy (3% Cd), 0.5-2% of Na, Ca, Sr, Ba, Zn, Hg, B, Ti, Zr, Sn, As, Sb, Bi, Se, Te or Mn was added separately or in combination with one other. Corrosion tests of these alloys in 2.5% salt water showed that (1) the ternary or quaternary alloys containing 3% Cd and 0.5-1.0% of Ca, Sr, Ba, Hg, As, Se, or Te and (2) the binary alloys containing 0.5-1.0% of Ca, Sr, Ba and Hg (especially in the quenched state), have comparatively high resistance to corrosion. The hardness of the Mg-Cd alloy, as-cast was increased by adding Ca, Sr or Ba, especially the last; other mechanical properties of the Mg-Cd alloy are improved remarkably by adding Ca, Sr or Ba. Suitable temperatures for rolling the Mg-Cd and Mg-Cd-Ca alloys were determined as 350° and 300° C., respectively. TS (10b)

Present Day and Future Problems in the Development and Use of Magnesium Alloys (Heutiger Stand und Zukünftige Aufgaben der Entwicklung und Verwendung von Magnesium-Legierungen) E. LAY. *Metallwirtschaft,* Vol. 17, Dec. 2, 1938, pp. 1279-1281. Review. Brief reference is made to the gas refining process of Luschenowsky, which not only gives a highly refined product, but also results in better tensile and elongation values for castings. Purified Mg-Al alloys can be rolled at higher speeds than unpurified material, speeds of about 250 ft./min. being used instead of the conventional 100 ft./min. The possibility also exists of rolling cast slabs instead of extruded slabs. Sheet produced in this manner can be cold-rolled 40%, resulting in good properties after annealing. Reference is made to the development of high strength, ductile Mg alloys with the statement that in Germany they are trying to use for alloying additions only metals that are found in Germany. GA (10b)

The Influence of Impurities on Copper (Les Impuretés du Cuivre et Leurs Influences) L. GUILLET. *Cuivre et Laiton,* Vol. 11, Dec. 30, 1938, pp. 535-537. Review. The principal impurities in Cu, the forms in which they occur, and their effects on properties are described. O forms Cu_2O, which is less than 0.009% soluble in Cu at 1000° C. The Cu-Cu_2O eutectic with 3.4% Cu_2O melts at 1065° C. The presence of Cu_2O makes deforming especially in the cold, more difficult. The tensile strength of rolled sheets is increased by the oxide, but ductility is reduced. Beyond 0.09% O, fatigue resistance is reduced considerably. On the other hand, some O must be present if sound castings are to be made. The solubility of H is very small in solid Cu but increases above the melting point rapidly with rising temperature; between 1085° and 1550° C., it increases 2½ times. H in solid Cu forms blisters and cavities, and the simultaneous presence of O and H leads to reactions in which the H reduces the Cu_2O during solidification. Fe forms a solid solution with Cu, with about 0.3% Fe at 800° C. Increasing Fe content increases the difficulty of rolling. Tensile strength is increased, elongation reduced; fatigue and resiliency are not affected. The presence of Fe raises the recrystallization temperature of cold-rolled Cu; *e.g.* for 0.06% Fe it is 210°-250°, for 1.38% Fe between 300° and 400° C. Electrical conductivity is considerably reduced; with 0.06% it is only 90%. S is harmful to ductility in cold state but has no effect on hot-deforming. Bi is soluble in Cu only to the extent of 0.002% at 980° C.; it retains its own individuality in Cu, melts at 270° C. and makes Cu fragile if this temperature is exceeded. An addition of 0.05% Bi makes Cu brittle in the cold; this sensitivity to embrittlement by Bi is increased if the Cu is highly deoxidized, as Bi_2O_3 is less harmful than the metal itself. Pb is insoluble in Cu, occurs in globules between Cu grains, and makes Cu brittle when hot, but less so than does Bi; it requires 10 times as much Pb as Bi to produce the same effect. In the presence of O, the effect of Pb is still less harmful; Cu with 0.45% Pb can be readily hot-rolled in the presence of O. Arsenic appreciably lowers the melting temperature, and forms a solid solution with 7.25% As at 650° C., with practically the same limit at ordinary temperature. Ultimate strength is increased by As becoming 34,000 lbs./in.^{2} with 1% As; elongation, resiliency and conductivity reduced considerably. Machinability is not affected. Sb forms a solid solution, containing 9% Sb at 450° C. Additions of Sb even lower than 1% Sb make hot-working of Cu more difficult. Tensile strength and fatigue limit are somewhat increased by 0.2% Sb; elongation and resiliency are not affected. In general, impurities forming solid solutions are sometimes harmful to hot-working and always reduce electric conductivity. Gaseous impurities that can escape during solidification result in physical defects of sometimes considerable importance. Ha (10b)

Electrical Conductors. G. A. PERCIVAL *Electrical Rev.,* Vol. 123, Sept. 23, 1938, pp. 420-421. Review. Ratio of thermal to electrical conductivity of Cu alloys varies at 20° and 200° C., although results at both these temperatures lie on a single curve when thermal conductivity is plotted against product of electrical conductivity and absolute temperature (Lorenz ratio). Electrical conductivity of Cu and Al cables varies with degree of drawing, the physical endurance limit increasing as a linear function. There is evidence of a slower increase in endurance limit of Cu than of Al, as the degree of reduction during drawing is increased. Electrical conductivity of Al is unaffected by decrease in area reduction, while that of Cu decreases with working down to 80%, after which it increases up to 90% reduction. Cu-Al alloys containing Mg, annealed at 100° and 205° C. and measured at 0 and —192° C. give practically constant Lorenz numbers, the aging curve for resistance following a hyperbolic function. Additive material in initial W batch appreciably affects the nature of final product causing either a sagging or a non-sagging wire. Composition and heat treatment of W slug during manufacture is of as much importance as treatment during fabrication of lamp, with regard to life and lumen maintenance. Small amounts of Cu substantially raise the recrystallization temperature of Ag. By slow cooling of Al-Mg alloy, solubility of Mg in Al decreases rapidly from 15.3% at 415° C. to 2.8% at room temperature. With more than 2.8%, the alloy may have a homogeneous or heterogeneous structure, according to cooling rate. Quenched, specific resistance increases from 3.27×10^{-6} ohms for 0% to 9.65×10^{-6} with 11.8% Mg. With increasing Mg, the temperature coefficient decreases, while cold working does not affect electrical conductivity. Method of manufacture, apart from composition, affects ultimate product, as in the case of Ni-Cr alloys. For these, crucible melting is preferred. Slag must be removed and occluded gases eliminated as far as possible before pouring. After casting, bars should be rolled and then ground before forging at 1300° C. and rolling again at 1150° C., all as a preliminary to final cold drawing. Dumet wire, consisting of alloy steel core with a Ag layer over which is swaged pure Cu, is used for leading-in wires of electric lamps and radio tubes. Composition of core and treatment are of equal importance in producing material with proper conductivity and coefficient of expansion. MS (10b)



Light Alloys for Aircraft. Problems of their Fabrication and Application. H. SUTTON. *Metal Ind., London,* Vol. 53, Dec. 16, 1938, pp. 581-584; Dec. 23, 1938, pp. 609-612; Dec. 30, 1938, pp. 637-640. Up-to-date review of some less familiar phases. The use of Al castings is favored because of the ease of quantity production and lower cost. The heat-treatable casting alloys, which form a very important group, may be subdivided into cast alloys heat-treated at low temperature only, and alloys "solution annealed" and then given low temperature heat treatment. The simple low temperature treatment lowers the elongation without rendering the castings unduly brittle but increases the ultimate and proof stresses. Also, because the internal casting stresses are released, the danger of future distortion is reduced. The double heat treatment is principally to develop high strength properties. In the wrought alloy field, the duralumin type alloys are most important. The quantity of Mg-alloy castings used in aircraft is very large and appears likely to increase in the future. The low density of the alloys, the mechanical properties, good general standard of quality obtainable in castings, and the excellent machining properties are all important practical points to the aircraft constructor. Further, the modern methods of protection against corrosion have permitted satisfactory service life to be obtained under all but the most severe conditions of use. Pressure-tight castings may be made of the 3-10% Sn, 2-6% Al, 0.25-4.0% Ag, balance Mg alloy. Two types of Mg alloy are used for sheet in aircraft: 2% Mn, balance Mg or the Al-Mg alloy with up to 9% Al, up to 1.5% Zn, and up to 1% Mn. Mg alloy propeller blades have shown remarkable progress; an 8-9.5% Al alloy with small amounts of Zn and Mn is used. A point of major practical importance in connection with application is recognition of the notch sensitivity of Mg-rich alloys in both cast and wrought forms. The new Ce-Co-Mg alloy appears promising. The protection against corrosion of Al-rich alloys by use of cladding with pure Al, has established itself strongly in aircraft construction. For severe conditions of corrosion, the protection of unclad alloys by anodic treatment followed by good varnish systems is very effective. Two types of organic protection used on anodic coatings are lanolin and paint. Lanolin itself its very effective under mild conditions. For severe conditions, a new mixture of lanolin, chromate and resin gives a much stiffer surface and has shown very promising service results. In paint systems, the use of chromates in the primer is now general practice with light alloys. In regard to anodic treatment, the Bengough-Stuart process is normally used, but the sulphuric acid process has found some application. The Bengough-Stuart process has been found generally free from damaging effects, such as loss of metal and lowered fatigue limit. In sulphuric treatment, under certain conditions, appreciable loss of metal and injury to fatigue properties may occur. Three chromate treatments are used extensively in England to produce protective coatings on Mg-alloys: (1) Acid chromate bath treatment, with the parts immersed in a cold solution containing 15 parts bichromate by weight and 20-25 parts by volume of conc. nitric acid for a short time. (2) immersion for 6 hrs. in a gently boiling solution containing 1.5% dichromate, 1.0% potassium alum and 0.5% caustic soda. (3) Immersion for 30 min. in a briskly boiling bath containing 3% sulphate, 1.5% ammonium dichromate, 1.5% potassium dichromate and 0.5% ammonia. These are followed by an application of Zn chromated primer and a surface coat. Fluoride and chromate cartridges have been used in fuel tanks with promising results. Surface treatment on light alloys of the type capable of affording general protection against corrosion give considerable general improvement of the performance under corrosion-fatigue conditions; complete protection was not afforded by any of the treatments applied. Practical experience has shown it inadvisable to bend or form extruded sections in high strength alloys in the solution heat-treated and aged condition. Considerable progress has been made in the spot welding of Al and its alloys. Spot welding has so far been applied only to light secondary structures. The point has not yet been reached at which spot welding can replace riveting in primary aircraft structures. 20 references. RWB (10b)

The Vapour Pressure of Zinc in Brasses. R. HARGREAVES (Univ. Cambridge) *J. Inst Metals,* Vol. 64, 1938, Advance Copy No. 823, 10 pp. Original research. The pressure of Zn vapor in equilibrium with Zn-Cu alloys containing from 1 to 51% Zn and in equilibrium with some Al brasses and Ni brasses was determined at different temperatures to within 25° C. of the melting points of the various alloys. The lower limit of temperature was such that the vapor pressure of Zn was only 1 mm. of Hg. Extrapolation to considerably lower temperatures will probably be reliable. Ni lowers the vapor pressure of Zn more than the same amount of Cu, but Al has the opposite effect. Curves of temperature against % Zn for different pressures of Zn vapor show breaks that are in fair agreement with the accepted phase boundaries in the Cu-Zn system. The effect of loss of Zn and gain of Zn on the surface during heating was studied. When the loss or gain was small, there was little effect, but when it exceeded some 4 mg./cm.^{2}, the surface was roughened. JLG (10b)

Investigation of Creep and Fracture of Lead and Lead Alloys for Cable Sheathing. H. F. MOORE, B. B. BETTY & C. W. DOLLINS. *Univ. Illinois Bull.,* Vol. 35, Aug. 19, 1938, pp. 1-90. Original research. Experiments on creep of Pb and Pb alloys, and the special methods that were developed to obtain sufficiently reliable results, are described in full. Tensile creep tests carried to fracture showed 3 well-defined stages: (1) A preliminary stage during which creep starts at a relatively high rate that diminishes as the stage proceeds; (2) a second stage, in which the creep rate remains nearly constant; (3) an accelerating stage, in which the creep rate increases, the specimen "necks down" and fracture finally occurs. The tests were made on 25 specimens at 200 lbs./in.^{2} at 110° F. for 2000 hrs., and creep determined by the McVetty method. At high stresses, the relation $v = AS^n$ is fairly reliable, where v is the creep rate, and S the tensile stress; at low stresses, n was found not to be constant. The creep resistance of Pb and Pb alloys diminishes rapidly with increasing temperatures, and the creep rate increases faster than does temperature. Creep under low stresses is very sensitive to slight structural changes that even escape metallographic detection; the creep behavior of Pb and Pb alloys at room temperature resembles creep behavior of steel at high temperatures. The fracture under load can be expressed by the formula $TS = TS' - K (\log t\text{-}l)$ where TS is tensile strength for a given length of time t, and TS′ the tensile stress that will cause fracture in 10 hrs.; k is an experimental constant. Ductility of Pb and Pb alloys under long time tests tends to decrease with length of time of test. A theory of the mechanism of creep is given that postulates the occurrence of creep both in atomically disorganized metal at grain boundaries and also along planes of least atomic resistance within crystals. 26 references. Ha (10b)

Aluminum Alloys in the Railroad Industry. A. H. WOOLLEN. *Metals and Alloys,* Vol. 10, Jan. 1939, pp. 1-7. Review of the application of Al and its alloys to the railroad industry, with particular reference to the present tendency to reduce weight and thus increase payload. The transportation industry is today the largest consumer of Al produced in America, and was one of the earliest consumers, for in 1894, only 8 yrs. after discovery of the modern Al reduction process, there was built a light weight car in which Al seat-frames were used. Wrought Al alloys are particularly well adapted to railroad car construction, because of their generally high strength/weight ratio. Elasticity modulus is lower than that of steel, so that deeper sections in Al are required, but redesign for Al usually results in a lighter, stronger construction with better resistance to impact loads. The corrosion resistance of Al and workability of Al have also made it useful. Heat-treated 53S-T alloy is widely used for side-sheets, and 4S in workable tempers for roof-sheets. 3 railroad companies have adopted Al alloy cabs for reducing locomotive weights. (10b)

The Acute Tin Pest III (Die akute Zinnpest III) ERNST COHEN & W. A. T. COHEN DE-MEESTER. *Proc. Koninkl. Akad. Wetenschappen Amsterdam,* Vol. 41, Oct. 1938, pp. 860-866. Original research. Alloys were melted in a high vacuum by adding 0.01-0.05% pure Mg, Zn, Ni and Cd to 99.996% pure Sn and rolled from 15 mm. to 0.2 mm. Traces of Mg in white Sn produce acute Sn pest; the occurrence of the Heyn-Wetzel phenomenon serves as a plausible explanation (see *Metals and Alloys,* Vol. 9, Nov. 1938, p. MA 672 L/1). The considerably retarding action of traces of Bi on the occurrence of the Sn pest is interpreted on the basis of observations by Mason & Forgeng (see *Metals and Alloys,* Vol. 6, Apr. 1935, p. MA 333 L/3) regarding the crystallization of Sn-Bi alloys. EF (10b)

Heavy-duty Bearings, Performance of Various Materials under Load. L. M. TICHVINSKY (Westinghouse Elec. & Mfg. Co.) *Product Eng.,* Vol. 10, Jan. 1939, pp. 22-23. Descriptive. Metallurgical and physical behavior of bearings for high pressures are discussed. Cd base alloys, with small additions of Ni, usually 3%, are now widely used and are superior to babbitt bearings. While a Sn-base alloy is molten at 300° C., a Cd bearing with 1½% Ni is still useful at this temperature; at other temperatures the hardness of the Cd-base alloys is about twice that of the Sn bearing. 10 references. Ha (10b)

Light Metal Pistons for Diesel Engines (Leichtmetallkolben für Dieselmotoren) *Automobiltech. Z.,* Vol. 41, Oct. 25, 1938, pp. 537-540. Practical. Materials for Diesel engine pistons have to fill the following requirements: High strength and durability; low weight; good thermal conductivity and low expansion. The thermal conductivity of light metals is 3 times as high as that of cast Fe; their specific gravity is ⅓. Two types of alloys are recommended. Al-Cu alloys with small additions possess very good machinability and heat conductivity; expansion is rather high. Al-Si alloys with small additions show small expansion, good strength and hardness at elevated temperature, and good wear resistance; conductivity is lower and the machinability is poor. RPS (10b)

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8859

11 · CORROSION AND WEAR

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Developments in Soil Corrosion and Pipe Protection. F. N. SPELLER & V. V. KENDALL. *J. Am. Water Works Assoc.*, Vol. 30, Oct. 1938, pp. 1635-1647. Review of recent developments. The informal conferences on soil corrosion and protective coatings held from time to time by the National Bureau of Standards stimulate thought and research. Most important developments or trends in pipe protection in the water works field are: The general application of Portland cement concrete or spun bituminous coatings for prevention of corrosion and tuberculation on the inside of water pipe; improvements in details of instruments and methods of surveying soils for their corrosivity and for stray currents; and the use of better and thicker coatings and improved means of application. Reconditioning of old pipe lines is now more economical and more widely applied in the oil and gas industry. Cathodic protection has now been successfully used for 10 years to protect gas mains. In most cases, field lines and often city lines can be economically saved by this means, if protective coatings should fail. The possible application of cathodic currents to water mains should be investigated and provided for in the original design of the system, where there is a chance that it may be needed to give permanent protection. VVK (11)

Making Soil Corrosion Survey by Using Electrolytic Test. I. A. DENISON (Natl. Bur. Standards) *Oil Gas J.*, Vol. 37, Sept. 22, 1938, pp. 96-98. Descriptive. The electrolytic cell test is described and its correlation with actual corrosion on a pipe line system found to be 70% or better. Procedure for a soil corrosion survey consists of mapping and collecting samples of the soils along the pipe line right of way at intervals of ½ mile; testing the soils by the electrolytic cell test; arranging the soils in order of decreasing corrosiveness as indicated by the cell test; calculating the probable number of leaks that will occur per 100 ft. in each soil type on an 8 in. line in 33 years by the equation $L = 0.017\ I$, where L = number of leaks in 33 years per 100 ft. of 8 in. pipe and I = average current density over the potential range of 0 to 0.3 voltage; calculate percentage of reconditioning corresponding to the leak frequencies by $R = 160\ L$, where R = length of line reconditioned per 100 ft.; estimate annual cost of maintaining pipe line system against corrosion; plot coating cost, repair cost and total cost against annual cost of combating corrosion as ordinate and length of the line as abscissa; the minimum in the total cost curve is the line of demarcation between soils requiring protection and soils in which the pipe can be laid bare. VVK (11)

Pipe Line Currents. J. CAMPBELL STIRLING (Stanolind Pipe Line Co.) *Oil Gas J.*, Vol. 37, Sept. 22, 1938, pp. 142, 144. Excellent discussions of currents on pipe lines is given. The author's conclusions are: "It is my opinion the currents on pipe lines (except those in areas infested with stray currents from electric railways) are in most part the result of chemical action of soil solutions on the pipe and that the currents originate on the pipe surface. If my assumption be true, the laws of electrolysis are not applicable to pipe line corrosion. If we assume that the currents do not originate on the surface of the pipe but are engendered by electrolytic potential differences, independent of the line, then the laws of electrolysis hold. But, if this be true, we shall have a complex case of battery action, and from our knowledge of the phenomena of pipe line currents, we will know that the currents found on any pipe line will be the resultant or summation of currents from many sources." VVK (11)

Practical Application of the Langelier Method. CHAS P. HOOVER. *J. Am. Water Works Assoc.*, Vol. 30, Nov. 1938, pp. 1802-1807. Whether or not a water is saturated with calcium carbonate can be determined by the Langelier formula (see *Metals and Alloys*, Vol. 8, July 1937, p. MA 442 L/6). If undersaturated, a protective coating of carbonate will not be deposited and the water will be corrosive; if oversaturated, precipitation will result. A nomogram is given for the rapid calculation of the saturation pH and the saturation index when the total solids, alkalinity and calcium are known. VVK (11)

Investigation of the Suitability of Heat Resistant Materials for Combustion Engines. Part II. Resistance to Scaling (Untersuchung über die Eignung warmfester Werkstoffe für Verbrennungskraftmaschinen. II. Teil. Zunderbeständigkeit) F. BOLLENRATH, H. CORNELIUS & W. BUNGARDT. *Luftfahrtforschung*, Vol. 15, Oct. 10, 1938, pp. 505-510. Original research. The effect of temperature, composition of exhaust gases and of an anti-knock addition to the fuel on the scaling resistance of 9 heat resistant materials was investigated. The alloy additions to Fe fell within the following ranges: 0.3-2.12% Si, 0.52-12.6% Mn, 10-29.4% Cr, 2.2-60.3% Ni, 0-11.2% W, 0-8.9% Mo, 0-1.8% Cu, 0-1.88% Ti, 0-35% Co, 0-1.35% Ta + Cb. The testing temperature range was 600°-1000° C. (± 5° C.) and the time was 50 hrs. The exhaust gas compositions were (a) 11.5% CO_2 + 3.5% O_2, (b) 6.5% CO_2 + 11% O_2. The amount of scaling was determined gravimetrically. The alloys on Ni-Cr basis showed excellent stability up to 800° C. The 12.3% Mn-8.9% Mo steel scaled badly. At 900° C., a 19.3% Cr, 10.3% Ni, 1.35% Ta + Cb steel loses its scaling resistance. Two steels with higher Ni and Cr scaled notably at 1000° C. A 60/15 Ni-Cr alloy showed about the best results. In the waste gas containing an excess of air, the scaling resistance changed but little. The same holds for an addition of ethyl-fluid to the fuel. This is in disagreement with observations by Bandel & Carius (unpublished results) who exposed Cr-Ni-W valve steel at 850° C. to liquid and gaseous Pb bromide. No traces of Pb were found chemically in the scale by Bollenrath & coworkers. Microscopic examination also proved the absence of Pb migration along the grain boundaries at 1000° C. Only decarburization at lower testing temperatures was found in some steels. The attack of Pb takes place in a reducing atmosphere and at lower temperatures during the start and shutdown of the engine. The greater amount of scaling due to the addition of anti-knock agents, observed by others may be attributed in reality to the higher operating temperatures of the engine rather than to the addition of the agent. For Part I see *Metals and Alloys*, Vol. 10, Mar. 1939, p. MA 181 L 9. EF (11)

Corrosion Research and Corrosion Prevention (Korrosionsforschung und Korrosionsverhütung) GERHARD SCHIKORR. *Chem. Fabrik*, Vol. 11, Mar. 30, 1938, pp. 157-159. Review. Postulations of Nernst are used as a basis for considering contradictory phases of corrosion theory. A point often overlooked is that corrosion is nearly always a chemical reaction. Because of the low velocities with which many metals corrode, it is important that corrosion rates be studied. Placing metals in order of the electromotive series often leads to mistaken impressions regarding their corrosion resistance. Some of the incorrect theories developed through wrong interpretation of results are: (1) Rapid corrosion always occurs between 2 unlike metals, (2) impure metals are more prone to corrode than pure, (3) deformed metals corrode more than unstrained metals, and (4) certain types of corrosion are due to stray currents. Each of these points is discussed to show where errors arise. The need for investigation of secondary corrosion properties is stressed, an outstanding example of which is atmospheric corrosion of Fe and steel. PCR (11)

Corrosion Due to Cavitation and the Impingement of Drops (Anfressungen durch Hohlsog und Tropfenschlag) H. MUELLER. *Stahl u. Eisen*, Vol. 58, Aug. 18, 1938, pp. 881-888. Review. Cavitation in ship propeller screws, water turbines and pumps, as well as drop impacts in steam and free jet turbines are discussed and the similarity of the phenomena brought out. The destruction of the material by cavitation and drop impact depends largely on the water velocity, which must reach a certain boundary value. The attack progresses from sharp notches and its beginning depends on the smoothness and hardness of the surface. However, no definite relationship has been found between the severity of attack and the hardness and structure. A Wöhler fatigue curve can be set up for repeated stressing by means of a liquid, substituting the water velocity for the magnitude of stress as in ordinary mechanical testing. The stresses set up by drop impact are analyzed in an attempt to explain the type of cavitation caused thereby in a flat, hard surface. 23 references. SE (11)

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Powdered Titanium Hydride applied to the surface of a number of metals and alloys, when heated in a vacuum or hydrogen atmosphere, dissociates into nascent titanium and nascent hydrogen. The released titanium alloys with the base metal forming an alloy of lower melting point than the base metal. Under these conditions, this alloy wets the surface of the parent metal and spreads over its surface by capillarity, completely covering every crack or projection with a thin continuous layer. This silver-like titanium-rich layer gives additional protection to the parent metal from corrosion and erosion. The formed protective layer cannot be chipped off from the surface of the parent metal. The composition of the protective layer can be varied in wide limits. The process can be applied in its present stage of development to surfacing small articles such as bronze valves, steel pipe elbows, etc. In the future it will be extended to the treatment of articles of any size or design.

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Metallic hydrides are dissociated on heating above 300° C. and give off large volumes of nascent hydrogen.

They are recommended as the source of a supply of 100% pure hydrogen.

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The Effect of Sulphur and Phosphorus in Steel on Corrosion (Ueber den Einfluss des Schwefel- und Phosphorgehaltes im Stahl auf die Korrosion) WOLFGANG STINNES. *Doctor's Thesis, Univ. of Münster,* 1938, 24 pp. Original research. After a brief literature survey on the problem the results of experiments carried out on a large number of different steels are described. The steels were specially prepared, with S contents up to 0.25% and P contents up to 0.5%; some of the steels were Cu-free, and others contained 0.3% or 0.6%. Also, commercial irons and steels were subjected to supplementary tests; these included Armco ingot Fe; Aston wrought Fe; high strength steel St. 37 with and without Cu content; steel St. 52; and 2 types of P-Cu steels (Patina steel of Vereinigte Stahlwerke). Before corrosion testing, all steels were mechanically and microscopically tested. The corrosion tests comprised tests in rural and industrial atmospheres, city water and artificial seawater in continuous or intermittent immersion, in salt solutions and in acids. The known decrease in atmospheric rusting of steel effected by small Cu additions was substantiated; increase of the Cu content from 0.3% to 0.6% brings about further decrease of rusting in industrial atmospheres. Increased P content also causes an essential decrease in the amount of corrosion in the atmosphere, as well as in water, and in salt solutions with alternating submersion tests. Whether the same holds true for permanent submersion tests cannot be definitely stated yet, but at least the effect of P is less pronounced. Increased S content caused a pronounced increase in corrosion on rusting in air and alternating submersion, whereas with permanent submersion no dependence of corrosion on S content was found. The effect of high S contents (0.2%) was totally eliminated by 0.3% Cu addition. Increased corrosion by a certain amount of S can also be made ineffective by about the same amount of P. Cu addition to steels with higher P contents caused additional decrease of corrosion by exposure in industrial atmospheres as well as by intermittent submersion in various electrolytes; in rural atmospheres, continuous submersion and also with intermittent immersion in certain agents Cu showed no enhancement of corrosion resistance. The nature and structure of the rust layers were considerably affected by S, P and Cu. S causes the layers to be porous and brittle, whereas P and Cu make them smooth and tight. It was proved that the effect of P on corrosion is electrochemical in nature. This could not be substantiated in regard to S. The change of H-ion concentration occurring in the electrolyte during the course of corrosion is affected to a considerable extent by the S, P and Cu content of the steel. The solubility of steel in acids was influenced by higher S contents to a minor extent, but by P to a considerable extent; Cu decreases the solubility in acids. By corrosion tests in NaCl solutions with varying acid contents, a H-ion concentration of pH_4 was determined as the dividing line between corrosion and solubility in acid. 44 references.

GN (11)

Investigation with a Liquid-impact Apparatus for Studying the Deterioration of Metallic Materials by Water Impingement (Untersuchungen mit einem Tropschlagapparat zur Erforschung der Zerstörung metallischer Baustoffe durch Wasserschlag) WILHELM MANTEL. Appendix by M. VON SCHWARZ & W. MANTEL on **Cavitation Investigation of Steel** (Tropfenschlagversuche mit Stahl) *Forschungsarb. Metallkunde Rontgenmetallog.,* No. 21, 1937, 62 pp. Original research. Both ferrous and non-ferrous alloys were studied by subjecting specimens to a high-velocity water spray for different periods of time. Attack was determined by change in weight and by examination of the surface. Some of the specimens were etched before testing. The resistance of a given material to cavitation increased as the grain size decreased. Non-metallic particles tended to start attack. In some materials attack was concentrated at the grain boundaries at the early stages. Fatigue may be responsible for the beginning of cavitation in ductile materials, and the possible hardening by cold work, as measured by Meyer's "n", may influence the resistance. Cast Fe has a low resistance because attack starts at the graphite. A eutectoid steel has a greater resistance than a hypoeutectoid steel, and the resistance of the latter can be increased by normalizing. Hadfield's Mn steel did not have a high resistance to attack, but a cast high-Cr steel did. Alloys of the Stellite type had the most resistance.

JLG (11)

Study on the Passivity of Iron and Steel in Nitric Acid Solution. Report XXIII. YOICHI YAMAMOTO. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 34, Oct. 1938, Abstract Suppl., p. 46. In English. Original research. The influence of nitrates of several metals added to HNO_3 solutions on the electrode potential of Fe was studied. It was found that the electrode potential of Fe was raised by the addition of ferric, mercuric and silver nitrate. It was confirmed that the appearance of the passivity of Fe in HNO_3 solution was facilitated through the addition of ferric, mercuric or silver nitrate and that the small addition of other nitrates of metals such as Na, Mg, Al, Mn, Zn, Cr, Co, Ni and Cu to the HNO_3 solution had no effect on the appearance of the passivity of Fe. (For Part XXII, see also *Metals and Alloys,* Vol. 9, June 1938, p. MA 384 R/1.)

EF (11)

The Effect of Hydrogen on Steels and their Constituents. (Action de l'Hydrogène sur les Aciers et leurs Constituants) L. JACQUÉ. *Chimie et Industrie,* Vol. 40, Nov. 1938, pp. 850-862. Review plus original research. The problem of decarburization and general alteration of steels and the impairment of their mechanical properties by the action of H_2 arises in the synthetic ammonia industry and in the hydrogenation of solid and liquid fuels. Temperatures of 400°-600° C. and pressures of 1,000-5,000 lbs./in.^{2} and higher occur. The alteration by hot H extends to a great number of ordinary and special steels, the rate of attack varying widely with the composition and increasing with the pressure and temperature. Generally the change is particularly noticeable in hyper-eutectoid steels. The mechanism of the phenomenon is comparable to cementation at rather low temperature, in the reverse direction. Local corrosion may create abnormal stress distribution in the surface, which is favorable to failure. Various special steels with pearlitic structure also show a similar behavior. Semi-hard 2-3% Ni-steels, containing no Cr or only a small percentage (1%), are extremely sensitive to decarburization. Some improvement may be achieved by previously tempering around 850°-870° C. Superficial scratches form points of attack, since local separation of the crystals facilitates the penetration of H_2. The altered zones of the steel are not only deprived of Fe_3C but also show a network of fissures that is the more pronounced the higher the C-content of the metal. These 2 effects penetrate gradually and replace each other, frequently following a common front parallel to the surface. It seems well established that below 200° C., H under several hundred atmospheres pressure produces no alteration in ordinary mild or semi-hard steel. Alloy steels belonging to the group of semi-hard steels and containing about 1% Cr show a somewhat higher limit of attack but cannot be used at temperatures above 350° or 400° C. High-strength steels with higher Cr content (5-7%) and with less C have an improved resistance, which may be satisfactory in many cases. Generally the mechanical resistance of steels exposed to H_2 attack decreases more rapidly for high-C steels. Whereas the altered steels show almost total absence of elongation, Cr-Mo steels stay practically unchanged; the elongation is slightly increased, which indicates that some annealing took place. Ni accelerates decarburization. 3-6% Cr-steels exposed to 150 atmospheres pressure of H_2 at 500° C. did not suffer any change in weight. The steels subject to attack show considerable swelling and their surface turns bright.

RPS (11)

Corrosion of Metals in the Soap and Allied Products Industries. G. L. COX (Internatl. Nickel Co.) *Ind. Eng. Chem.,* Vol. 30, Dec. 1938, pp. 1349-1355. Results of corrosion tests made in plant equipment used in the production of soaps, fatty acids, and by-products from these processes are reported. The results are discussed in the light of plant experiences, and typical examples of service records are cited. The alloys studied (nominal compositions are given) included cast iron, alloy cast irons, mild steel, various stainless steels and irons, Hastelloy C, Inconel, Monel, nickel, Cu and Pb. For equipment used in the Twitchell process for fat splitting, Monel and Inconel are highly useful, particularly because the danger of Cu contamination is obviated. The superiority of Ni-Resist over plain cast Fe is notable. For autoclaves operating at higher temperatures and pressures, Inconel is shown to be superior to Ni. In the separation of the sweet water from the crude fatty acids, ordinary steel equipment would be adequately durable, but Ni-clad steel glycerol-bleach tanks are used to avoid Fe contamination; the corrosion rates of all metals tested, except Pb, were low for this operation. Inconel and a Mo-bearing stainless steel (19 Cr, 12 Ni) were particularly resistant as fatty acid stills: Monel is highly serviceable for bubble caps and piping. Soapmaking presents less serious corrosion problems than does processing of the fatty acids; raw material storage and soapmaking equipment are chosen on the basis of avoiding metallic contamination of the product. Caustic storage tanks and handling equipment should preferably be made of Ni. Ni-clad steel is used for treating-tanks and evaporator bodies and Ni-Resist for filter press plates of spent-lye-treaters, glycerol-salt evaporators and salt recovery boxes.

MEH + FPP (11)

Corrosion Protection of Al-Cu-Mg Alloys by Means of Diffused Covering Layers (Korrosionsschutz von Al-Cu-Mg-legierungen mit Hilfe durchdiffundierter Deckschichten) H. KOSTRON. *Aluminium,* Vol. 20, Nov. 1938, pp. 775-784. If an Al alloy is protected against corrosion by cladding (by welding) 0.01-.0.015 mm. of pure Al on it and the metal is then annealed, the protective action of the pure Al layer is not impaired, although after annealing, it has been diffused through by the alloying elements Cu and Mg and no longer exists as pure Al layer. The concentration gradient for Cu from the interior and from the exterior reduces the potential gradient of Al-Cu/Al, which reduces danger of corrosion. This is helped by the practically homogeneous structure of the alloy that has been formed on the surface by diffusion as contrasted by the non-homogeneous structure of the base alloy. 10 reference and 32 illustrations of structural conditions.

Ha (11)

Oxidation of Contacts. G. W. NICHOLSON. *Electrical Rev.* Vol. 123, Oct. 14, 1938, p. 544. Formation of oxide on metal contacts and rate of oxidation depend largely on heat generated in apparatus. Heating usually present under normal operating conditions is sometimes enough to start oxidation. When arcing is produced, resulting temperatures may be high enough to melt contact metal, causing very rapid oxidation. On solidifying molten Ag melted in air, most of the Ag_2O dissolved in it is forcibly ejected by spitting, leaving a blistered surface. Roughness sets up excessive heating resulting in ruin of the apparatus. When solidification takes place under high pressure, Ag_2O is retained in the metal. At temperatures below its melting point Ag is completely resistant to oxidation. This has led to the practice of silvering the surfaces of contact metals that normally oxidize freely. Because of its low melting point, Ag can be used only where there is little or no arcing. Ag alloyed with Au up to about 1/3 its weight absorbs O_2 when melted, and spits on solidifying, but adding only 2½% Cu to Ag prevents spitting. Most of the Ag alloys used as contacts oxidize to varying extents. Vibration generally renders contacts more subject to oxidation. Moisture accelerates oxidation, especially after a definite oxide thickness has been built up. Line contact lessens tendency to oxidation. Mechanical pitting, common with Ag and some Ag alloy contacts, increases resistance with resultant heating and often oxidation. Adding Pt to Ag raises melting point and increases hardness. Alloy is highly resistant to oxidation both under atmospheric and severest working conditions. Impact value is high and there is little danger of pitting. Adding Au to this alloy has little effect on oxidation. Pd-Ag alloy has a high melting point and good resistance to oxidation, so that an alloy of 70% Ag, 25% Pd and 5% Co is used very often for its oxidation resisting qualities. Standard Ag, containing 7½% Cu, is much harder than pure Ag, has greater electrical resistance, and is subject to atmospheric oxidation greatly accelerated by heat. Thick oxide scale is formed rapidly at a temperature well under its melting point of 894° C. Resistance of Ag alloy to oxidation can be increased by oxidizing its surface a few times and cleaning and polishing after each process. Apparently removal of base metal in form of oxide from alloy surface leaves a surface of almost pure Ag. Ag alloy contacts with wiping action thus have increased oxidation resistance through being cleaned each time they operate. MS (11)

Intercrystalline Cracking in Boiler Plates. C. H. DESCH. *N. E. Coast Inst. Engrs. & Shipbldrs.*, Advance Copy, Jan. 1939. Review of historical background and some research at the N. P. L. "Caustic embrittlement" is redefined as caustic cracking, since the metal between the cracks is not necessarily brittle. The cracks are definitely intercrystalline and differ from fatigue cracks (which are transcrystalline) or corrosion fatigue (which are of irregular path independent of grain boundaries). Evidences of caustic cracking and similar cracking in service in the chemical industry but not necessarily under caustic environment are cited, indicating that cracking results from a combination of chemical reaction and stress. Tests made on boiler plate under stress and immersed in caustic solutions above 250° C. and at 300 lbs./in.^{2} pressure showed that failure occurred rapidly for stresses above the yield point, but no typical caustic cracks were observed. For stresses below the yield point, failure did not take place. Notched samples failed at lower stress, and cold rolled material had a higher resistance to cracking. No definitely intercrystalline cracks were found, but it was observed that in regions of high stress, nonmetallic inclusions were much enlarged by chemical action. Corrosion fatigue tests made on plain and riveted strips of boiler plate indicated that this could not be the cause of intercrystalline cracking. Tests are now under way for micro examination of cracks in small specimens heated in pressure vessels for short periods. The results of Schroeder, Berk & O'Brien (*Metals and Alloys,* Vol. 8, Nov. 1937, pp. 320-330) on caustic cracking, taking place only when the NaOH contains about 0.2% Na_2SiO_3, could not be confirmed by the N. P. L. with the purest NaOH obtainable. Necessary conditions for caustic cracking are concluded to be stress, alkaline solution at temperature of 100° C. or above and opportunity for concentration of the solution in capillary spaces. Both H_2 and the deposit of Fe oxide formed by the reaction enter into the process, but an explanation is lacking. WB (11)

Dairy Utensils of Aluminum (Milchwirtschaftliche Geräte aus Aluminium) P. SCHWERBER. *Tech. Blätter,* Sept. 25, 1938, pp. 571-575. Research. Results of investigations of the Preussische Versuchs.- und Forschungsanstalt für Milchwirtschaft at Kiel, show that there are no objections whatsoever against the application of Al and Al alloys to dairy utensils. An interesting table shows the different behavior of milk at rest or agitated on sheets of Cr-Ni stainless steel, welded stainless steel, 99.5% pure Al, Duralumin, Anticorodal, tinned-Cu, tinned-Fe, Ni, Cu, Argentan, German silver, brass, Fe and Zn, tested at temperatures from 5° to 85° C. Cr-Ni steel, Al, Duralumin and Anticorodal gave the best results and remained absolutely unstained without weight loss. GN (11)

Giving CHROME STEELS greater resistance to heat

In certain industrial operations—such as oil refining—steel is subjected to a service involving an extraordinary combination of stress, high temperature and corrosion. Too severe for ordinary grades of plain carbon steel! Yet a 5% chromium addition to the steel more than paid for its cost, in terms of its unusual resistance to corrosion and to stress at high temperature.

The chief disadvantage of this type of steel, however, was a tendency to harden and become brittle—even when cooled at normal rates from temperatures encountered in welding or annealing. This was due to its chromium content.

As a solution to this problem, a Titanium-treatment for chrome steels was developed which has effectively overcome the air-hardening tendency. Due to its strong affinity for carbon, Titanium practically removes all carbon from combination with chromium (preventing the formation of martensite on cooling) and thereby keeping the steel soft under all conditions.

This problem is typical of the many on which TAMCO Engineers and TAMCO Research have offered helpful assistance. Perhaps you, too, can benefit through TAMCO co-operation. Write: The Titanium Alloy Manufacturing Co., Niagara Falls, N. Y. (Representatives in leading cities throughout the world.)

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Thermodynamics and Corrosion (Thermodynamique et Corrosion) MARCEL POURBAUX. *Métaux et Corrosion,* Vol. 13, Nov. 1938, pp. 189-193. Discussion. The roles of pH and of potential in corrosion phenomena are indicated graphically where the values for pH are on the abscissae and the values of the potential E on the ordinate axis. By relating these 2 factors, 3 potentials are apparent: *Oxido-reduction potential,* if the oxidation and reduction elements are both dissolved (as in the case of a Pt electrode immersed in solution of Cu^{+} and Cu^{++} ions); *Dissolution potential,* if the oxidation or the reduction element is a solid (the case of Cu electrode in a solution of Cu^{+} and Cu^{++} ions); and *electrode potential* as in the case of the H electrode. Thermodynamically no substance (solids, liquids, gaseous or dissolved) can exist in stable equilibrium in the presence of an aqueous solution except where there is suitable pH and potential E. Dilute solutions of H_2SO_4 do not corrode Cu in the absence of air at ordinary temperatures, especially if the potential is less than 0.15 to 0.20 volt, but it will corrode at potentials higher than 0.20 volts. Thus, in Cu-Cu_2 and CuO corrosion diagram there are 2 fields, one of thermodynamical possibility of corrosion and one of passivity. It can also be considered that all metals have fields of corrosion and fields of non-corrosion, their form and magnitude varying according to the metal considered and according to the constituents in the solution. The corrosion of a physically and chemically homogeneous Fe surface immersed in an acid solution, thus causing H evolution, can be expressed as follows: $Fe + 2H^{+} \rightarrow Fe^{++} + H_2$. This reaction can be considered as the sum of 2 reactions as follows: One of oxidation of the Fe to ferrous ions, and one of reduction of the H ions into H_2 gas. Thus, it can be shown that when the metal corrodes and causes H evolution, the value of its potential should lie within 2 limits, the potential corresponding with the equilibrium of the oxidation reaction or the dissolution potential and the H electrode potential. In a solution of pH =4 Fe corrodes and causes H evolution. The 2 limits of the potential are calculated for this case as lying between —0.50 and —0.24 volt; by experiment, it was actually found to be —0.42 volt. The case of Fe in contact with Pt and that of Fe in contact with Zn in solutions were also considered. GTM (11)

Corrosion by Gas Due to the Special Conditions of Chemical Synthesis (Korrosion durch Gase bei den besonderen Bedingungen der chemischen Synthesen) H. J. SCHIFFLER & E. BERLECKEN. *Chem. Fabrik,* Vol. 11, Aug. 17, 1938, pp. 385-390. Review plus experiments. In the ammonia-synthesis process, the conditions of high temperature and pressures lead to reactions between the H_2 of the gas and the C in the steel to form CH_4 and other hydrocarbons. A study of the effects of these reactions on the impact strength of an unalloyed steel, a 1% Cr-Mo steel and a 5% Cr-Mo steel showed the latter to be unaffected by variations in temperature and pressure. The other 2 steels had decided drops in impact strength at 200° and 400° C. and about 50 and 75 atmospheres pressure, respectively. The improvement of the H_2-resisting steels must be accomplished by using low C content, minimizing inclusions and by alloying, *e.g.* with Cr in connection with Mo and W, and with such carbide stabilizers as Ti, V, Ta and Cb. At pressures of 1000 atmospheres Cr-Ni steels are used because of their heat resistance, even though these alloys are susceptible to H_2 embrittlement. Elements that resist H_2 are also good nitride formers, so that failure can occur by cracking due to the formation of a brittle nitride layer. Austenitic Ni steels are resistant to nitriding. In the manufacture of HNO_3, ferritic Cr steels are replacing austenitic Cr-Ni steels. Susceptibility to intergranular corrosion in the former occurs above 900° and between 500° and 700° C. in the latter. Ni steels are known to be especially sensitive; Cr steels are resistant to H_2S and SO_2 gases. A Cr-Si-Al steel has been found useful where H_2- and S-containing gases must be handled at 1000° C. PCR (11)

Corrosion Behavior of Aluminum as Dependent on its Purity (Das Korrosionsverhalten des Aluminiums in Abhängigkeit von dessen Reinheitsgrad) E. ZURBRÜGG. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb., 1939, pp. 13-15. The effect of impurities in Al on its behavior against some corrosive agents is summarized in the following table:

Impurity (max. 1%)	distribution in the Al	dil. HCl 10%	dil. H_2SO_4 20%	dil. HNO_3 25%	conc. HNO_3 (1.4)	dil. NaOH	seawater (oxygenated NaCl-sol'n)
Fe	heterogeneous	v. s.	c.	—	—	c.	—
Si	heterogeneous	v. s.	—	—	c.	—	—
Si	homogeneous	—	0	0	—	0	—
Cu	homogeneous	v. s.	c.	c.	—	c.	v. s.
Zn	homogeneous	c.	0	+	—	—	—
Mg	homogeneous	0	0	0	—	+	0
Mn	heterogeneous	c.	—	—	—	—	—
Mn	homogeneous	—	—	0	—	0	—

"v.s." means corrosion resistance very strongly deteriorated, "c." considerably deteriorated, "—" slightly deteriorated, "O" not affected and "+" improved. Another table gives the amount of material dissolved in the same agents and the quantity of H_2 developed for Al from 99.99 to 98.5% purity. Ha (11)

The Rate of Corrosion of Aluminum in Caustic Soda (Ueber die Lösungsgeschwindigkeit des Aluminiums in Natronlauge) M. STRAUMANIS & N. BRAKSS. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb. 1939, pp. 5-11. Original research to determine whether the rate of solution of Al depends on its purity, and whether its corrosion by a base is due to an electrochemical or a chemical reaction. Experiments with purest (99.998%) Al show that impurities accelerate corrosion. Also, local elements are formed in alkalies, but their effect is somewhat restricted by formation of a layer of $Al(OH)_3$. In the case of a pure Al, that layer is not stable, as $Al(OH)_3$ is quickly dissolved in the excess of the alkali to form sodium aluminate. Here, therefore, the electrochemical reaction is the determining one for the speed of solution. In impure aluminum, however, the current intensity of the local elements is so high that the $Al(OH)_3$ formed cannot be dissolved any more rapidly by the alkali; in this case, the chemical reaction—the dissolution of $Al(OH)_3$—is the determining factor, and impure aluminum dissolves in alkaline solutions with about the same velocities whatever the purity of the metal. Since Al dissolving in alkalies has an appreciably less noble potential than in acids, the e.m.f. of the local elements is much higher, and a much smaller amount of impurities causes acceleration in rate of solution. 16 references. Ha (11)

Correlation of an Electrolytic Corrosion Test with the Actual Corrosiveness of Soils. IRVING A. DENISON & ROBERT B. DARNIELLE. *J. Research Natl. Bur. Standards,* Vol. 21, Dec. 1938, pp. 819-830. Original research and correlation. The corrosiveness of soils along a 128-mile section of a pipe line system was estimated from data on the occurrence of leaks and length of line reconditioned and from the results of an electrolytic corrosion test. The development of leaks with time as influenced by reconditioning is illustrated for soils differing in corrosiveness. The corrosiveness of associated soils, as indicated by data on leaks and repairs and the results of the corrosion test, increases as the drainage becomes more deficient and as the soil becomes heavier in texture. The variation of corrosiveness with depth is illustrated for typical soil profiles. A rough linear correlation was observed between the actual corrosiveness of the soils and the results of the electrolytic test. The relative corrosiveness of the soils along approximately 80% of the total length of the pipe-line system was correctly indicated. WAT (11)

The Binary Alloys of Indium and Tin. COLIN G. FINK, ERIC R. JETTE, SIGMUND KATZ & FRANK J. SCHNETTLER (Columbia Univ.) *Trans. Electrochem Soc.,* Vol. 75, 1939, Preprint No. 1, 5 pp. Original research. In, a by-product of the Zn industry, is more plentiful in the earth's crust than some "common" elements such as Hg, I, Bi, Au. In is softer than Sn. Thermal and X-ray methods were used in the investigation of the alloys. In the solid state, In is soluble in Sn to the extent of 1.5%. The solubility of Sn in In is 10% at 100° C. Two compounds were found to exist, one containing 10% In and the other 75% In. The complete thermal diagram will be given in a later publication. Intermittent immersion corrosion tests of the metals and alloys were made in 3% NaCl solution. In and Sn pitted at the end of 2 weeks. An alloy containing a few per cent of In did not pit but formed a uniform protective coating. Using oxalic acid as the corroding medium, pure Sn dissolved completely in 2 weeks. About half of the In dissolved. Alloys containing 38-50% of In resisted the acid fairly well. AB (11)

Oxidation-resistance in Copper Alloys. L. E. PRICE & G. J. THOMAS. *J. Inst. Metals,* Vol. 63, 1938, Advance Copy No. 806, 8 pp. Original research. Theoretical considerations show that an alloying constituent added to prevent high-temperature oxidation should have a sufficient affinity for O, and should on heating form an oxide film of high electric resistance. If possible, the radii of the cations in the protective oxide should be small, and the oxide must not be one that is deficient in cations. These principles provide an explanation of the good resistance to oxidation conferred on Cu by Be and Al, and suggests a method by which it could be increased. The method consists in forming an oxide at a suitable temperature and with a low O pressure, so that the film contains little Cu. Experiments indicated that superior resistance could be produced in this manner. JLG (11)

Some Apparatus and Material Problems (Ueber einige Apparatur und Werkstoff-Fragen) BRUNO WAESER. *Chem. Ztg.,* Vol. 62, Nov. 9, 1938, pp. 809-812. Practical review of materials used in chemical industry. Plated metals are made from C-steels, heat resistant steels, Mo-steels, creep-resistant steels rolled together with plating metals (Cu, brass, Ni, Monel, Inconel, stainless steel, Ag, etc.) at welding heat. Acid proof steels are used for cellulose boilers, for containers in which paraffines are oxidized to fatty acid and for containers for the regeneration of Co-containing Fischer-Tropsch catalysts by means of hot nitric acid. Ta and Ta coatings on Fe or Cu are popular because of their chemical resistance. Light metals are resistant to lyes, fluorides and fluoric acid, and many non-acid organic substances such as benzine, benzol, etc. Some modern testing methods are listed. RPS (11)

12 · GENERAL

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

Progress in Powder Metallurgy. W. D. JONES. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 51-55. A survey of past work and future possibilities. With the exception of two half-hearted attempts to examine the properties of binary alloys made from powder, there is apparently no organized investigation underway. Ta and Cb can be worked in powder forms, similar to W. Compared with W, the particle size is coarse, sintering temperatures are more closely controlled and more intimately connected with particle size. The recovery of scrap is difficult. The application of Zr powder is based mainly on its high heat of combustion and low ignition temperature. It is used chiefly in ammunition primers and smokeless flash powders. There is demand for contact material that will withstand the high temperatures and high compressive stresses of electrical welding, and powdered metal products serve the purpose well. Powdered metals have been suggested for coinage. The most interesting development among the precious metals is the manufacture of the "Phantom" Au and Ag alloys, and their application to the production of compacted porous jewelry. Powder metallurgy permits control of the density of the jewelry within practical limits and, human nature as it is, the lower density material is likely to appeal to purchasers by virtue of the greater size possible for the same price. The normal range of density of these materials is from 60% of complete solidity upwards, the superficial layers being quite free from porosity, and the interior porosity too fine to appear to the naked eye. Porous sintered Mg-masses have been cited as suitable for pyrotechnic purposes. Ti metal powder, when heated, ignites very rapidly. The hydride, on the other hand, commences to dissociate at 400° C., and not until all the H is evolved does instantaneous ignition proceed. The hydride is therefore safer to handle than the powder. As far as powder metallurgy is concerned, the most important application will probably be as a deoxidant when added in small amounts to compacts prior to sintering. Considerable work has been done on porous bronze bearings. There are 2 very serious obstacles in the path of progress in powder metallurgy of Fe: Imperfect distribution of C in steels manufactured from carbonyl powder, and the impossibly high price of Fe powders. There are many cases where very fine powders do not compact as well as coarse powders. The reactions that occur during sintering depend first on the closeness of contact of neighboring particles and then on the internal stresses. By a method of atomization of molten metals, a means is provided of not only powdering molten metals and alloys, but of powdering molten emulsions so that fine powders of mixtures, such as Cu-Pb, Al-Pb, Ag-Ni, and specialties such as Al-glass, are available. 57 references. RWB (12)

The Modern Method of Manufacturing Aluminum Powder. H. MEYERSBERG. *Aluminum & Non-ferrous Rev.,* Vol. 3, Nov. 1938, pp. 397-399; Dec. 1938, pp. 5-8. Practical. The flattening process, achieved by means of a special kind of ball mill, is made continuous. An inert gas flows through the drum, carrying the finely ground particles out. The powder is then separated for grain size and the oversize is fed back into the flattening drum. The gas is re-circulated through the mill and the grading apparatus after its separation from the powder. Enough foil is fed into the drum to replace the weight of the powder carried away. The powder is then polished in a special drum containing brushes. Fine powder requires a longer polishing period than a coarse one. A gas stream is used in order to retard the flow, to whirl the powder and to convey a slight amount of heat. After this polishing operation the powder is ready for shipment. The inert gas used as protective atmosphere for the various steps of manufacture is generated by burning coal gas. About 3.5% O_2 is added by means of an adjustable Bunsen burner arrangement. The gas is cooled and scrubbed, and the analysis checked. The new process permits production of thinner particles as compared with the same mesh powder produced by stamping. This is advantageous mainly where powder is used for paint. Good burning qualities are obtained by leaving the Al powder unpolished; this is applied for fireworks and explosives. See *Metals and Alloys,* Vol. 10, Feb. 1939, p. MA 120 L/3. RPS (12)

Powder Metallurgy of Iron—Special Reference to "Pacteron." *Iron & Coal Trades Rev.,* Vol. 137, Dec. 16, 1938, pp. 1013-1014. Development of carbonyl Fe powder for sintering is reviewed. An interesting application is the sintering of carbonyl-Fe powder into the form of porous blocks that can readily be cut to shapes and sizes suitable for the manufacture of molds; the material can be arranged to have a wide range of thermal conductivity, and by the local application of pressure before or during sintering, it is possible to arrange for non-porous areas to act as chills. The material has the necessary porosity for the transmission of gases and is superior to sand molds in strength. Other suggested applications include use in storage battery plates, filter bodies for gases and liquids, lamp wicks, safety devices on gas burners, catalysts and as porous Fe bearings. "Pacteron" is by-product fines from cast iron grit used for shotblasting. Analysis: 3.16% T.C., 1.13 Si, 0.58 Mn, 0.126 S, 1.154 P, particle size from 80 mesh to minus 400 mesh. Compaction is made at 16,000/in.^{2}, consolidation starts at 400° C. Strength increases as temperature is raised to 800° C. CBJ (12)

Metallurgy of Zinc. FRANCIS P. SINN. *Mining & Met.,* Vol. 20, Jan. 1939, pp. 18-19. Economic review of Zn industry for the past year. Production was curtailed to bring it into line with consumption. In metallurgical practice, electrolytic production increased the purity of product and reduced cost. Electro-galvanizing has firmly established itself, and commercial application to sheet is being investigated. Retort smelters have increased output and improved recoveries. This was done by careful attention to character and sizing of both sinter and reduction fuel, with the result that more Zn was charged per retort. Reduction of Zn in gaseous suspension made progress. Demand and high price for Cd make the metal a by-product of considerable importance to Zn producers. VSP (12)

Synthetic Materials with Special Metal Properties (Kunststoffe mit besonderen Metalleigenschaften) RICHARD HANKE. *Chem. Ztg.,* Vol. 63, Feb. 1, 1939, p. 80. Original research. Finely dispersed ferromagnetic metal powders are introduced in molten materials, such as plastics, wax, resins, solutions or molten metals. By means of a magnetic field, they are forced into a position that they keep after solidification. The field alone, or together with gravity, effects an increase in density at a predetermined spot. Compacts of high specific gravity, great hardness, good magnetic properties and electrical conductivity can be produced. The conductivity is higher in the direction of the magnetic field than in other directions. Bodies with varying conductivity values in different directions can be produced. RPS (12)

Preliminary Spectrographic and Metallographic Study of Native Gold. WELTON J. CROOK (Stanford Univ.) *Metals Tech.,* Vol. 6, Feb. 1939, T.P. 998, 14 pp. Original research. Au nuggets and one Pt nugget were examined by spectrographic methods to determine the constituents present, after careful cleaning to remove gangue. Results indicated that ordinary native Au probably consisted of an alloy of Au, Ag and Cu. In addition, Fe is probably always present, but possibly in the form of Fe-S or Fe-O inclusions. Metallographic examination of some nuggets showed presence of inclusions and, in some, strain lines. Other elements found in native Au included Al, Sb, Pb, Mo, Ni, Ti and V. The Pt nugget contained Al, Au, Cu, Ir, Fe, Ni, Os, Rh, Ru and Ag. JLG (12)

Bibliography on the Manufacture, Properties and Testing of Steel Castings. *Iron Steel Inst., Third Report Steel Castings Res. Committee,* 1938, pp. 201-294. An annotated bibliography in which articles are listed under the following headings: 1. General Steel Foundry Practice. 2. Manufacture of Steel for Castings. 3. Design of Steel Castings. 4. Cleaning of Castings. 5. Gates, Runners and Chills. 6. Molding Practice. 7. Production of Special Castings. 8. Cooling Phenomena and Defects in Castings. 9. Welding of Steel Castings. 10. Heat Treatment of Steel Castings. 11. Properties, Tests and Examination of Steel Castings. 12. Steel Foundry Plants. JLG (12)

books

Carbon Monoxide Asphyxia

Cecil K. Drinker

Oxford University Press, New York, 1938. Cloth, 6½ x 9½ in., 276 pages. Price $4.50.

Industry, although it is a heavy user of CO-bearing gases, is in general, quite ignorant of its physiological effects. This book fills a very persistent demand for authentic information on this important subject. The subject is discussed from the viewpoint of the physiologist as well as the physician, yet it is in language that is readily understandable by the average layman. Among the topics covered are: Respiratory physiology and biochemistry of carbon monoxide asphyxia; acute poisoning by carbon monoxide and the after-effects; what constitutes harmful exposure; some statistics on carbon monoxide asphyxia and common sources of carbon monoxide; the problem of chronic exposure to carbon monoxide; treatment of carbon monoxide asphyxia; and detection and determination of carbon monoxide in air and in the body. The author is to be complimented upon his clear, logical presentation. It is believed that all those interested in this subject will find this volume very valuable.—R. R. SAYERS.

Adjusting Your Business to the New Legislation

Tax Research Institute of America, New York, 1939. Simulated leather looseleaf binder, 9½ x 10 in., 908 pages. Price $12.85. ($10 to Institute members).

Although this handbook is not metallurgical, we believe that it is of considerable value to executives and managers of metallurgical industries and that their attention should be called to it.

The information contained in it shows how those interested can avoid possible trouble and expense by knowing in advance what steps to take with regard to each one of several Federal and State laws which have been passed recently regulating and affecting business practices.

Some of the "business control" laws which are explained and discussed include the Wage and Hour Law, the Labor Relations Act, the Pure Food and Drug Act, the Robinson-Patman Act, State Wage and Hour Restrictions, Anti-Monopoly Legislation and others. Specific recommendations are found in the handbook which outline steps that should be taken to meet the requirements of the various laws.

Of special value are some 29 pages devoted to "charts of business practices." This is pointed to as being "the first compilation of business practices ever attempted with a view to the legality of each specific practice." Thus, most business men are familiar with the practices they and their competitors use, but they do not know which of those practices are legal under the new legislation.—EDWIN F. CONE.

Oxyacetylene Welding

R. J. Kehl
Revised by M. H. Potter

American Technical Society, Chicago, 1938. Cloth, 5¾ x 8½ in., 130 pages. Price $1.25.

The authors approach their subject from the viewpoint that oxyacetylene welding has been selected as the correct process for the cases discussed, and proceed to offer advice and instruction for doing the job. As a general instruction manual for oxyacetylene welding, therefore, the book is very good, but one wishes there could have been some discussion of the applicability of oxyacetylene welding as compared with other welding processes for joining the individual metals covered.

The volume opens with a discussion of the equipment and technique characteristic of all oxyacetylene welding, then gives in turn the procedures and precautions to be followed for gas welding steel, stainless steel, cast iron, pipe, malleable iron, die castings, aluminum, copper, brass, bronze and lead. There are separate sections on the bronze welding process, hard surfacing, silver soldering, welding in automobile repair work, jigs for gas welding and costs of welding.

As in all books of this size, there are many omissions. Probably the most serious is the absence of any discussion of the welding of the low-alloy, high-strength steels, whose present and future application depends so much on their welding properties.

In some places the metallurgy is a bit sloppy—for example, malleable iron is characterized as gray iron with a decarburized skin in a paragraph that says "during the annealing process, the packing material absorbs the carbon from the surface of the casting. In this way the surface becomes really a steel, while the inside, or core, becomes gray cast iron." The malleable producers (and also those deluded souls that in using malleable for years have noted its superlative machinability) will be shocked to learn that "malleable iron is strong on the surface only, therefore it will not stand a great amount of machining and in this respect it resembles a steel forging."

However, this little book is not offered as a metallurgical treatise; for the purpose for which it is intended—brief instruction in oxyacetylene welding procedure—it can be recommended. —FRED P. PETERS.

Electric Heating in the Iron and Metal Industries

(*Elektrowärme in der Eisen- und Metallindustrie*)

O. Wundram

Julius Springer Verlag, Berlin, 1939. Paper 6¼ x 9 in., 64 pages. Price 2 RM.

This is No. 69 in Haake's *Werkstattbücher*. It is an elementary description of the fundamentals of electric heating with brief discussions of smelting, melting and heat treating furnaces, of electric welding, and of control devices.

The pamphlet is too small to do more than merely mention many important applications of electric heating. Controlled atmospheres are mentioned but no useful information given; such things as circulation of the atmosphere in tempering furnaces get tucked away with inconspicuous mention; the salt bath described is of antiquated design; and induction hardening is not mentioned. The fact that electric welding is dismissed in five pages exemplifies the cursory treatment of all topics.

Within the space limits used the information given is sound as far as it goes, but practically anyone who seeks information from the literature on the topics covered already knows as much as is presented here. There are no literature references through which a topic may be looked into further. As an elementary text book it may serve for German-speaking students, say of a trade school, to get their first introduction to the topic. It falls short of being of much value to the practising metallurgical engineer.—H. W. GILLETT.

Metals and Alloys (*Metalen en Legeeringen*)

A. G. Van Den Hoek & H. J. Mathlener Loderus

Nijgh & Van Ditmar, Rotterdam, 1938. Paper, 6½ x 9¾ in., 188 pages. Price 3.90 Fl.

This is an elementary text book covering a very wide field in introductory fashion. The arrangement is unusual. Starting with equilibrium diagrams with a side excursion into metallographic examination, the Fe-C diagram is discussed. The topic then switches to smelting and melting, first of cast and malleable iron, then of steel, next comes heat treatment of steel with some comment on precipitation hardening. Copper base alloys get a chapter, followed by one on other metals. The subject then switches back to alloy steels. Finally, mechanical testing, radiographic examination and determination of critical points are discussed.

The necessary brevity requires that most topics be treated in staccato fashion, which results in a certain degree of inaccuracy—as for example in the discussion of precipitation hardened copper steels—and of unbalance, as when carburizing gets half a page and nitriding three pages.

The student using this as a text book would have heard of a good many of the essentials upon which a metallurgical education is based, and, with amplification and explanation in the classroom, he might get a good grasp of fundamentals. For home study without an instructor, the reader would not get a balanced understanding of the field, nor is he introduced to the literature of the various topics. A score of rather advanced text books or detailed monographs is listed, but no reference is made to any periodical literature. While the Dutch text can be read by one who can read technical German, it is unlikely that English-speaking students will find its study profitable.—H. W. GILLETT.

Spectrographic Analysis in Great Britain

A. C. Candler

Adam Hilger, Ltd., London, 1939. Paper, 6 x 9½ in., 80 pages. Price 7s. 9d.

This is a compilation of contributed articles (some unaccredited to a particular author) representing present application and uses of the spectrograph in some 28 British governmental and industrial laboratories. In the main the small or intermediate instrument appears to be the one most used, presumably because one plate suffices for the full range of air-emission spectra. Absorption work is not as yet extensive in the industries surveyed, which by and large are metallurgical in character.

Non-ferrous metal applications predominate but wider use for steel, and other metals with complicated spectra, is projected and several instances are noted. As to alloy steels the summary by F. G. Barker of the Bragg Laboratory, Admiralty Inspection Department, Sheffield, is of particular interest.

Both the internal standard and the comparative standard quantitative methods appear to be used equally but very few details of technique are given. The same comment applies to the use of arc *vs.* spark. In the examination of materials other than those metallurgical in character, flame spectra by both the Lundegardh and Ramage techniques have their proponents. One research laboratory uses the exploded wire method in certain instances.

Of perhaps most value to the general spectrographer, in addition to those already mentioned, are the chapters on Lead and Copper (by the Pirelli-General Cable Works, Ltd.—discusses applications of arc and spark); Zinc, Cadmium and their Alloys (by the National Smelting Co.—features preparation of sample); Zinc, Tin, and Antimony (by the Post Office Research Station—contains notes on a sparking device); Aluminum Alloys (by Birmetals, Ltd.—covers sensitivity as a variable); Aluminum and Magnesium Alloys (by the Government Chemists Laboratory); Paints, Varnishes and Fabrics (by the War Department Chemists, Woolwich Arsenal).

This compilation is far more than a sales booklet. While it is general in nature and gives few details of technique, there are a number of incidental comments on materials of interest to others than the spectrographer. The chief value of this survey will be to the chemist, metallurgist or executive contemplating installing a spectrographic laboratory. To such it is particularly commended. From the title, the experienced spectrographer will probably expect more than he will find in the text.—THOMAS A. WRIGHT.

An Introduction to Metallurgy

Joseph Newton

John Wiley & Sons, Inc., New York, 1938. Cloth, 6¼ x 9¼ in., 537 pages. Price $4.00.

This is a text book for an elementary course in metallurgy, and represents what the author wants his students to know before taking up advanced courses. As the author puts it, such a book is a skeleton, specialized text books are the flesh, and current literature is the life's blood.

Because the author is a professor at the University of Idaho, he is more concerned with routing the student along the paths of extraction of non-ferrous metals from their ores, than in physical metallurgy, and ferrous matters are not featured to the usual degree. He starts with 200 pages of physical, or as he terms it, "adaptive" metallurgy, taking up atomic and lattice structures, crystals, grain boundaries (we dislike to see the amorphous cement theory resurrected in a text book and "equicohesive temperature" set down as corresponding closely to recrystallization temperature) plastic flow, grain phenomena; thermal analysis, the phase rule and equilibrium diagrams, instanced by Pb-Sb, Au-Pt, Cu-Mn, Pb-Bi, Ca-Mg, Fe-C (this last in a couple of pages); physical and mechanical properties (creep is included, but a diagram that shows Stage 3 creep is the only one shown and the statement is made that creep differs from slip in that it has no self-hardening effect, which the student will need to unlearn later), correlation of structure and properties, 5 pages on corrosion; shaping of metals, 3 pages on welding; heat treatment, including precipitation hardening, with 3 pages to cover heat treatment, carburizing and nitriding of steels; industrial metals and alloys, in which these are listed with brief mention of uses, but without giving much idea of their engineering properties. This ends the section on physical metallurgy and one can almost hear the sigh of relief the author gave when this section was finished and he could turn to chemical metallurgy. The bones of the "adaptive metallurgy" section are indeed too bare to be very useful save to the beginner for whom the section is written.

The chemical metallurgy section goes along much better, the chapter headings are: Sources of Metals; Ore Dressing, Hydrometallurgy; Chemical Principles of Pyrometallurgy; Fuels; Combustion; Pyrometry; Pyro Processes; Electrometallurgy; Sampling, and Statistical Data on Production of Industrial Metals. A much less detached attitude is taken in these chapters, the author feels that the student will use the information, so that approach is more practical, less academic, but leans heavily on the non-ferrous side. Open-hearth steel melting is discussed in a dozen lines. The whole treatment is very condensed. In the preface the student is urged to supplement this volume by reference to more detailed texts, and each chapter ends with a selected list of such texts, as well as a set of problems for the student to solve.

The book is not a reference volume—it is solely and frankly an elementary text book, of which there are many. This one might well be chosen when the curriculum it introduces will put emphasis on chemical metallurgy. Its strength lies in the fact that it doesn't try to be a hand book or a reference book, but holds its content down to that which a beginning student can reasonably digest.—H. W. GILLETT.

Practical Aspects of Wire Rope

(*Die Drahtseile in der Praxis*)

Richard Meebold

Julius Springer Verlag, Berlin, 1938. Paper, 6 x 9 in., 68 pages. Price 6.60 RM.

Wire rope, a highly important metallurgical product, is also one about which very little has been written from the metallurgical viewpoint. This is an interesting and useful little book, but leaves the metallurgical gap still unfilled. It gives considerable detail on various types of construction, on splicing, and clamping, with some discussion of wear, corrosion and types of failure, but there is no discussion of structure or any metallurgical property of the steel itself.—H. W. GILLETT.

CURRENT news

Non-Ferrous Metals in American and Foreign Autos

An interesting comparison of the non-ferrous metals used in automobiles, trucks and buses in Germany, England and the United States has been made by M. Genthe in *Metallwirtschaft,* Vol. 18, Feb. 17, 1939, pages 138-142. Data for 1938 are used for Germany and 1937 statistics for England and the United States.

The data are compared in a variety of ways, i.e., in relation to total metals used in all industries, but the most interesting is on the basis of the weight of metal per vehicle. This needs to be viewed in the light of a slightly lower ratio of trucks plus buses to passenger cars in England, 1:33 against 1:4.15 for Germany and 1:4.3 for the United States. But a useful comparison is offered in pounds per vehicle as follows:

	Al	Cu	Pb	Sn	Ni	Zn	Mg
United States.....	12	64	95	5¼	4½	33	..
England	2¼	65	39	7¼	..*	8¼	..
Germany	33	40	44½	5¼	1	12¾	9

* Not stated.

Larger batteries and more zinc die castings are obvious in American cars, together with more nickel as undercoat for chromium as plating. It would have been interesting had data for chromium been available. Apparently English makers use thicker linings in babbitt bearings. The small English use of aluminum and the very high use of it and of magnesium in Germany are noteworthy.

Dix to be Institute of Metals 1940 Lecturer

The selection of Edgar Hutton Dix, Jr., chief metallurgist of the Aluminum Co. of America, to present the 1940 Institute of Metals Lecture of the American Institute of Mining and Metallurgical Engineers has been announced by Robert H. Leach, chairman of the Institute of Metals Division, A.I.M.E. Mr. Dix will give the 18th of this series of annual lectures at the meeting of the A.I.M.E. in February, 1940. The invitation to deliver this lecture is one of the highest honors given by the metals divisions of the Mining and Metallurgical Engineers. In the selection of the lecturers the choice is not restricted to residents of the United States and approximately half of the former lecturers have come from over seas.

● On and after April 15, 1939, the executive offices of Wire and Wire Products, the Wire Association, and the Quinn-Brown Publishing Corp. were located at the Stamford Trust Co. Bldg., 300 Main St., Stamford, Conn.

High Test Cast Iron

The British Cast Iron Research Association, 21 St. Paul's Square, Birmingham 3, England, is in process of examining high test cast irons made in commercial production. Data on a score of such irons are given in the First Report of the Research Committee on High-duty Cast Irons for Engineering Purposes. This report was presented last December to the Institution of Mechanical Engineers and will appear in full in the transactions of the Institution. It has been summarized in the British publications, *Foundry Trade Journal, Engineering* and *The Engineer,* in their issues for the latter part of December.

The Association will send copies of the preprint of the complete report to firms which might care to cooperate in supplying other commercial high test irons for an extension of this study, and offers to test commercial materials from any source. Cooperation of foundries in the U. S. is invited. A communication of March 27, 1939, states:

"This Association is prepared to test materials from any source in the same way, and would welcome the co-operation of foundries at home and overseas in supplying the necessary test bars.

For any given metal, the following bars would be preferred, although the largest and smallest sizes may, if desired, be omitted, and the set, fully marked for identification, should be addressed to the British Cast Iron Research Association, 21 St. Paul's Square, Birmingham 3, England.

One bar, diameter 2.1 in., length 27 in.
One bar, diameter 1.6 in., length 21 in.
One bar, diameter 1.2 in., length 21 in.
One bar, diameter 0.875 in., length 15 in.
One bar, diameter 0.6 in., length 10 in.

The irons can be plain or alloyed, ordinarily or specially processed, as cast or heat-treated (including malleableized), but it would be advantageous to know:

(a) Whether the material is plain or alloyed, and if so, what alloy additions have been made; (b) whether the material has been specially processed by ladle additions, soda ash treatment, etc., and whether it is a high steel mix; (c) in what type of furnace it was melted, and whether duplexed; (d) whether it has been heat-treated, and if so, what the heat-treatment was; (e) what the metal is ordinarily used for; and (f) whether it is a high duty iron for engineering purposes, or whether it is a special purpose iron (i.e., austenitic, high silicon or high chromium, etc.) for heat, wear, corrosion or erosion-resistance, or some other purpose in which strength is not a primary requirement. Any special-purpose iron will be welcomed, but high duty irons for engineering purposes, not having special properties other than high strength, should have a transverse breaking strength of over 2370 lb. at 18-in. centers, rupture stress of 62,750 lbs. per sq. in. on a 1.2-in. dia. bar, or a tensile strength of not less than 38,000 lbs. per sq. in. on a standard 1.2-in. dia. bar, which is machined to 0.8-in. for the tensile test.

The object of the investigation is to acquaint engineers with the progress in producing high duty irons and to provide the data which they need for use in design.

Battelle to Conduct Tin Research

Research on tin in this country by the International Tin Research & Development Council, representing the tin producers of the world, will be continued at Battelle Memorial Institute, Columbus, Ohio, according to the announcement by W. H. Tait, clerk to the council and Clyde E. Williams, director of Battelle. Arrangements have also been completed to have the tin research staff at Battelle available for the consideration of technical questions arising with American tin users.

In establishing this work at Battelle the International Tin Research & Development Council has chosen the most logical way of giving service to the various industries using tin in this country. The alternative of setting up an independent organization was considered. But when it was realized that even the smallest modern research unit must combine administrative staff, travelling representatives, specialists in chemistry, physics, metallurgy and engineering, a reference library, a press cutting service, and extensive equipment it became obvious that a much higher quality of service could be given by taking advantage of the facilities available at one of the large research organizations already established.

(Continued on page MA 316)

A DEPENDABLE SOURCE OF SUPPLY

FOR ALLOY AND CARBON STEEL SEAMLESS TUBES

ELECTRIC FURNACE AND OPEN HEARTH

Sales Offices or Representation in

Detroit
Chicago
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Atlanta
Seattle
San Francisco
Huntington
Pittsburgh
Minneapolis
Milwaukee
Washington, D. C.

CLASSIFICATIONS MANUFACTURED:

Boiler and Superheater Tubes
Cracking Still Tubes
Locomotive Tubes
Condenser, Heat Exchanger and Evaporator Tubes
Mechanical Tubes
Ball and Roller Bearing Tubing
Tubes for air conditioning and refrigerating equipment
Automotive Tubes
Pipe Size Tubing
Tubes for Miscellaneous Applications

HOT ROLLED—COLD FINISHED

GRADES FURNISHED IN ABOVE CLASSIFICATIONS:

Carbon Steels
S. A. E. Alloy Steels
Intermediate Alloy Steels for resisting normal temperature corrosion and corrosion fatigue.
Intermediate Alloy Steels for resisting high temperature creep, oxidation and corrosion.
Stainless Steels

Alloy Blooms, Billets and Bars
Carbon and Alloy Seamless Tubing
Tool and Fine Steels
Stainless Steels

Open Hearth and Electric Furnace Quality

LET US QUOTE ON YOUR REQUIREMENTS

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
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World's Largest Producers of Electric Furnace Steel

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GOOD WILL BASED ON GOOD STEEL

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SEAMLESS STEEL TUBES

ELECTRIC FURNACE AND OPEN HEARTH • ALL STANDARD AND SPECIAL ANALYSES

A Temperature Symposium

A symposium on "Temperature and its Measurement in Science and Industry" will be held under the auspices of the American Institute of Physics, 175 Fifth Ave., Nov. 2, 3 and 4, in New York. Consistent with the title, the symposium will broadly cover many fields, its primary purposes according to present plans being to (1) coordinate the treatment of the subject in the sciences and branches of engineering, (2) review principles and bring up to date the record of recent work, (3) accumulate contributions for a comprehensive text, to be published as soon as possible after the symposium is held, (4) reveal the subject as an important branch of physics and (5) supply schools with the information required for the improvement of curricula. The Institute confidently expects that a stimulating, valuable and unified program will be arranged, an aim which will require the help of many contributors.

A representative steering committee has been formed consisting of the Chairman, C. O. Fairchild, director of research, C. J. Tagliabue Mfg. Co.; Dr. E. F. DuBois, medical director Russell Sage Institute of Pathology and professor of medicine Cornell University Medical College; Dr. Gustav Egloff, director of research, Universal Oil Products Co.; Dr. John Johnston, director of research, U. S. Steel Corp.; Dr. Walter G. Whitman, head department of chemical engineering, Massachusetts Institute of Technology; and Dr. H. A. Barton, director, American Institute of Physics.

Those who are interested in taking part in this symposium should communicate with the Institute, or with Dr. R. B. Sosman, research laboratory, U. S. Steel Corp., chairman of the Metals Committee, at an early date, giving information regarding their field of work and the subject of the contribution they wish to make. Such contributions will be coordinated with the subjects of a group of invited papers, and assignments and divisions made.

Vascoloy-Ramet Opens Eastern Plant

A new plant for the manufacture of tantalum carbide wire, tube, sectional and shape dies, cutting tools and blanks, has been put into operation by Vascoloy-Ramet Corp., North Chicago, Ill. The plant, located at 415-421 Tonnelle Ave., Jersey City, N. J., occupies an entire one-story brick and steel building of approximately 6,000 sq. ft. floor space. The plant is on U. S. Highway No. 1, near the intersection of Pulaski Skyway, and a few blocks from the Journal Square tube station, affording convenient highway, rail and air connections with the industrial east.

Operations are under the direction of John Kontra, Joseph Hall and John Adler, who were formerly associated with the Union Wire Die Co. District sales and service are handled by Hayden G. Fulton, transferred from the North Chicago main plant. Teletype service has been installed for rapid exchange of order, engineering and delivery information with customers, and with the general offices in North Chicago.

A Rush Order for Electrodes

The story of how a Cleveland manufacturer recently filled a rush order for shipment to Arabia and got the cargo aboard ship at Brooklyn, N. Y., just 55 min. before sailing time, has been told by a Cleveland newspaper:

George A. Maurath, founder and head of Maurath, Inc., manufacturers of arc welding electrodes, received a cablegram from a European customer requesting a rush shipment of 3500 lbs. of electrodes. Instructions called for stainless rods of a special analysis to be placed aboard a ship leaving Brooklyn in 4 days for Arabia.

"With an average welding rod measuring 18 in. in length and having a coated diameter of 1/8 in. 3500 lbs. of rods is no small order," said Mr. Maurath. "Manufactured under the Maurath process from raw materials in so limited a time, it required 24 hrs. of service of practically every man and machine in the plant for 2 days." The full order was completed in 3 days, loaded on a truck and dispatched to Brooklyn, arriving there just 55 mins. before sailing time.

"Co-ordinating Committee" on Corrosion

In order to have, for their mutual information, a list of those working on corrosion problems and the topics of chief interest to them, an "American Co-ordinating Committee on Corrosion" has been set up, with representatives from the various technical societies concerned. These organizations and their appointed representatives are listed on p. 29 of the March A.S.T.M. *Bulletin*.

The societies have sent to the members of their various sub-committees concerned with corrosion problems, a questionnaire for listing the name, address and organization connection of the individual. The questionnaire also asks for a list of corrosion projects in progress, whether the results are available to others, and whether the individual is interested in exchanging corrosion experience with other investigators. It is desired that any investigators not reached by this canvass be given an opportunity to be listed.

The questionnaires are to be returned to F. F. Farnsworth, 463 West St., New York City, for compilation. He may either be asked for a questionnaire form, or the information may be sent him.

American Steel & Wire Metallurgists

Appointment of five new members to the main office metallurgical staff of the American Steel & Wire Co., Cleveland, subsidiary of U. S. Steel Corp., has been announced by J. S. Richards, manager of the metallurgical department of the company.

The appointments include L. F. McGlincy, who becomes division metallurgist on heating and hot rolling. He was formerly open-hearth and hot mill superintendent for the company at Worcester, Mass. R. H. Barnes, formerly district metallurgist in Cleveland, becomes division metallurgist on flat rolled products and strip. Assistant division metallurgist on high-carbon products is A. F. Ilacqua, formerly standard practice metallurgist at Worcester. John F. Occasione becomes assistant division metallurgist on coatings, whereas formerly he was in charge of similar work for the Cleveland district. New assistant division metallurgist on standard practice is J. E. Millen, who was formerly in charge of statistical work in the company's physical laboratory in the Cleveland district.

Metallurgical Research at Notre Dame

The mounting importance of metallurgical research has been emphasized at the University of Notre Dame with the establishment of a new research fellowship by John J. O'Brien, prominent South Bend industrialist.

In announcing the new foundation, Rev. J. Hugh O'Donnell, C.S.C., university vice-president, said that Mr. O'Brien's gift is in the form of a joint benefaction which will be designated as "The Miles and John J. O'Brien Fellowship in Metallurgy and Allied Sciences." It will provide funds for the pursuit of post-graduate study and research by men who intend to devote themselves to a life of teaching. Scholarship recipients, to be named annually, will be selected on the basis of proven ability, character and financial need. Father O'Donnell added:

"The University acknowledges this gift with pleasure and gratitude. The late Miles O'Brien was a charter member of our Board of Lay Trustees and served as treasurer of the board until his death in 1936. His brother John has been a devoted and loyal friend for many years and has cooperated with the various administrations in the furtherance of plans for the greater Notre Dame. This benefaction will help materially in the promotion of research work now being conducted under the supervision of Dr. E. G. Mahin, head of the department of metallurgy."

Mr. O'Brien is the president of the South Bend Lathe Works and his many years of keen interest in the promotion of increased research in engineering fields were shared by his brother during the latter's lifetime.

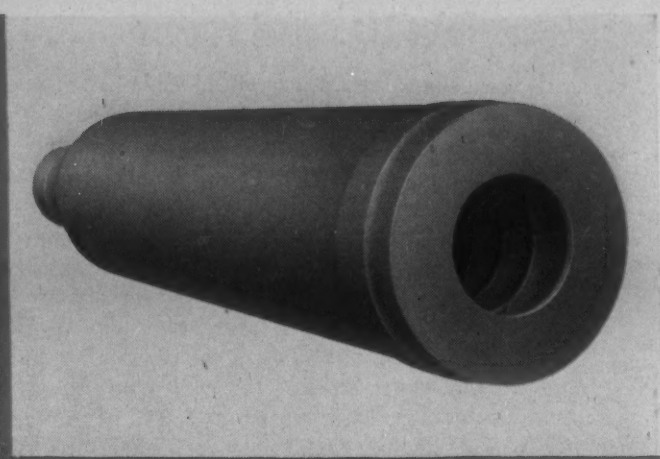
(Continued on page MA 318)

Better Heat-Resistant Alloys

Improve Performance—Cut Costs

● Specializing for over 21 years—producing tons and tons of heat- and corrosion-resisting castings week after week for this long period—have given ***Michiana*** metallurgists and foundrymen a fund of information covering the widest possible variety of applications.

Michiana Alloy Castings will improve performance—give uniformly longer heat-hour service—and reduce your production costs. Let us assist you in meeting your alloy requirements.

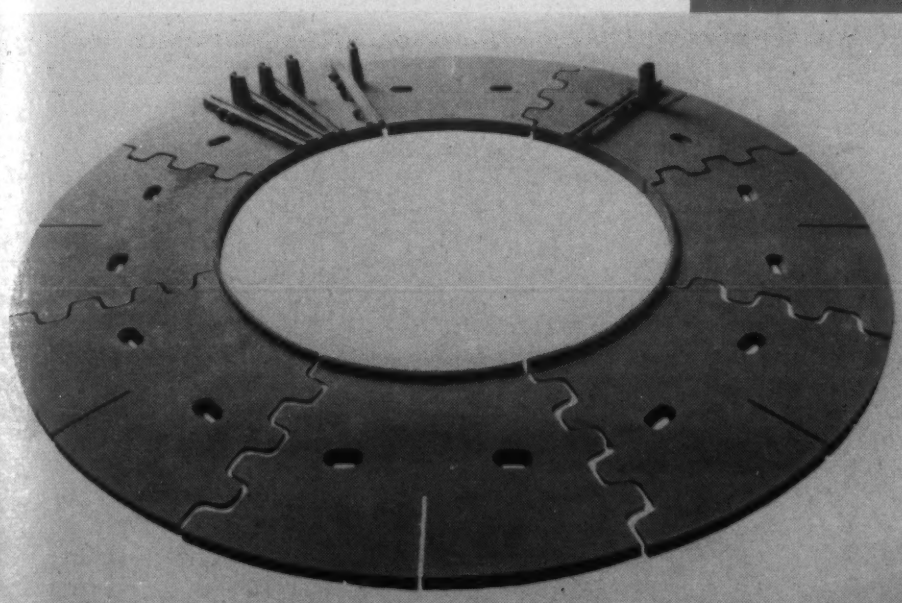


Above: A 3500 pound retort of MICHIANA Heat-Resistant Alloy having internal spiral flights or ribs. Used for heat-treating small metal parts.

At Left: Large hearth plate produced by MICHIANA for a leading electric furnace manufacturer.

MP CORP.

MICHIANA
Heat-Resistant and Stainless Steel
ALLOY CASTINGS



Above: This 10-foot diameter hearth plate for a rotary furnace was cast in sections—slots being left for expansion. The fixtures shown at the top are for holding plow shares during heat treatment.

Below: A group of disc type MICHIANA Heat-Resisting Alloy Rolls for sheet normalizing furnace. Barrels are centrifugally cast.

MICHIANA PRODUCTS CORP.
MICHIGAN CITY, INDIANA

Lower Price for Nickel Powder

It has been the continual endeavor of the producer of metal powders to reduce costs and prices whenever possible and thereby to widen and increase their use, according to *Metal Powder News,* published by Charles Hardy, Inc., New York.

It should be of interest to all those engaged in powder metallurgy that the price of nickel powder has now been reduced to one which is more comparable to that of other forms of refined nickel. This move should also prove an incentive to research and development work on products and alloys which involve the use of nickel powder. The new prices, in quantities of one ton or more, are as follows:—

150 Mesh	51.5c per lb.
200 Mesh	54.5c per lb.
300 Mesh	56.5c per lb.

The Mordica Memorial Lecture

At the directors' meeting held at Detroit in October, 1938, the idea of establishing an annual Wire Association Lecture to be presented at the annual meeting was first discussed. The thought behind the lecture is that in this way the association would be provided with an opportunity to honor various individuals who have done outstanding work and at the same time incorporate their names in Wire Association activities.

John Mordica was the first president of the Wire Association, and his name is also honored in the establishment of this annual lecture. A joint program committee will select a lecturer for the 1939 convention, and announcement will be made at a later date of the selection of the lecturer and the subject to be presented.

A.S.M. Group Meeting in Philadelphia

On Friday, May 19, the Middle Atlantic Chapters of the A.S.M.—New York, New Jersey, Penn State, York, Lehigh Valley, Philadelphia and Baltimore—will hold a group meeting in Philadelphia. A technical session is scheduled for the morning at the Manufacturers' and Bankers' Club, Broad and Walnut Sts., at 10:30, at which a paper will be delivered by Edgar C. Bain, assistant to the vice president in charge of research, U. S. Steel Corp. A luncheon will follow at the Club. A plant inspection trip to the Alan Wood Steel Co. and a tour of Valley Forge are on the afternoon program. A dinner in the evening will be presided over by Secretary W. H. Eisenman.

New Officers of Wire Association

At the annual meeting of the board of directors of the Wire Association, held at the Waldorf-Astoria Hotel, New York, recently, the following officers were reelected for the 1939-40 term: President—F. A. Westphal, superintendent, wire mills, Sheffield Steel Corp., Kansas City, Mo.; vice president, Ferrous Division—John C. Callaghan, works manager, Canada Works, Steel Co. of Canada, Ltd., Hamilton, Ont., Canada; vice president, Non-Ferrous Division—E. W. Clark, mechanical engineer, Wire & Cable Section, General Electric Co., Schenectady, N. Y.; executive secretary—Richard E. Brown, publisher, *Wire and Wire Products,* New York City.

Four new directors, whose 3-yr. terms of office commenced with the March, 1939, directors' meeting, were seated. These new directors are: D. D. Buchanan, assistant general manager, Union Drawn Steel Div., Republic Steel Corp., Massillon, Ohio; C. E. Johnson, superintendent, rod and wire mills, Bethlehem Steel Co., Sparrows Point, Md.; John A. Moritz, superintendent, wire mills, Keystone Steel & Wire Co., Peoria, Ill.; Sidney Rolle, assistant manager, Scomet Engineering Co., New York City.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Professor of Metallurgy desires position for three months starting June first. The possibility of developing into permanent position of added interest. Ph. D. in physical chemistry and physical metallurgy. Four years of industrial experience and eight years of teaching experience in engineering schools. Will consider either teaching or industrial position. Box MA-127.

POSITION WANTED: Metallurgist desires technical sales position. Employed, and for the past eight years, by nationally prominent manufacturer. Experienced in all phases of heat treating, physical testing, processing, fabrication, application and production of plain carbon, alloy and tool steels. Box MA-133.

HELP WANTED: Experienced pyrometer men for New York and Philadelphia, capable of producing and supervising district sales and services. Unlimited opportunity with growing organization. Proper remuneration. Box MA-135.

POSITION WANTED: X-Ray operator thoroughly experienced desires suitable connection. Box MA-136.

HELP WANTED: A research physical metallurgist is wanted by an industrial laboratory for non-ferrous alloy research. A man with graduate training and several years' experience is preferred, although one of unusual ability who did not meet both of these requirements would be considered. Box MA-137

POSITION WANTED: Metallurgical Chemist and metallurgist—control and research. Age 32, married, college graduate—B.S. Chemistry, cum laude; training in metallography. Eleven years experience ferrous and non-ferrous analysis. Physical testing of metals, sand control. At present time associated with high test gray iron foundry. Box MA-138

● The Lincoln Electric Co., world's largest manufacturer of arc welding equipment, Cleveland, announces the opening of a new office in Duluth, Minn., at 222 South 21st Ave., East. A stock of electric welders, electrodes and supplies will be maintained for serving the Duluth area.

● The Meehanite Metal Corp., Pittsburgh, has granted the right to manufacture Meehanite metal to The Lowes Foundry Co. of Lower Hutt, New Zealand, and Booth-MacDonald & Company, Ltd. of Christ-Church, Australia.

● The addition of two research engineers, Robert E. Adams and W. G. N. Heer, to the technical staff, has been announced by Clyde E. Williams, director, Battelle Memorial Institute, Columbus, Ohio. Both have been assigned to the process metallurgy division. Mr. Adams is a recent graduate of the University of Wisconsin. Mr. Heer is a metallurgical graduate of the University of Alabama, and was previously associated with the Tennessee Coal, Iron, & Railroad Co.

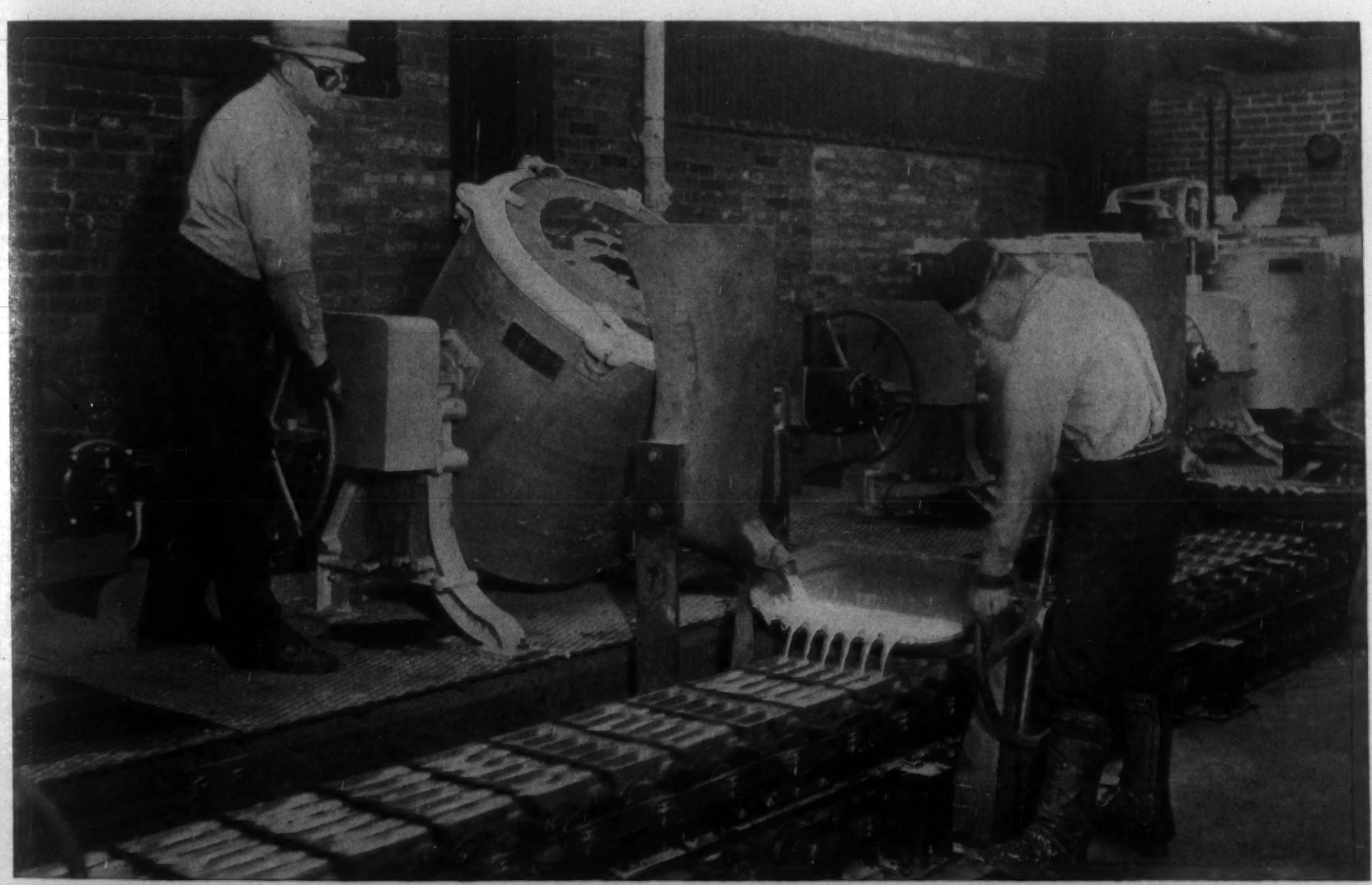
● The Aluminum Co. of America showed its new motion pictures, "Aluminum: Mine to Metal," and "Aluminum Fabricating Processes," to a group of invited guests, including trade and technical press representatives on March 29 in Room 1031, 1775 Broadway, New York. A cocktail party preceded the film showing. The pictures made a highly favorable impression.

PRODUCTION INCREASED 60% WITH MODERN GAS-FIRED ALLOY FURNACES

Important operating improvements—uniform heat distribution, radically reduced fuel consumption, and longer life for crucibles and crucible linings—were brought about by the installation of the GAS-fired furnaces shown below for the melting of alloys.

Production was increased about 60%, according to an estimate by the manufacturer, with a corresponding saving in all items which enter into the final cost of melting metals. Convenience of the modern GAS installation was a big factor in the up-to-date, efficient layout of the plant.

If you use heat in any of your plant operations, investigate the money-saving, profit-making efficiency of modern GAS-fired equipment.



Battery of GAS-fired furnaces for the melting of alloys. Photo courtesy of Campbell-Hausfeld Company, Harrison, Ohio.

There's Nothing Like GAS For

HARDENING NORMALIZING FORGING
ANNEALING BLUEING GALVANIZING
TEMPERING CARBURIZING CORE BAKING
MALLEABLEIZING NITRIDING
and many other Industrial Processes

THE TREND TODAY IS TO GAS
FOR ALL INDUSTRIAL HEATING

AMERICAN GAS ASSOCIATION
INDUSTRIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK

trends

By Edwin F. Cone, Editor

Metals and Alloys at the World's Fair

As our leading article in this issue we present a few examples of the special applications of metals and alloys at the New York World's Fair which opened April 30. Two trends are emphasized: Statues made of welded steels and murals constructed of metals. Expanding use of stainless steel is noted.

Metallurgical Education

We are impressed with the number of notices, which have recently come across our desk, of plans to establish, or the actual establishing of, courses or a series of lectures in metallurgical engineering. Involved in this trend are both universities and small local engineering schools. One of the latest is a scheme for a graduate course in metallurgical engineering at New York University, to be made up of lectures by men prominent in various lines of work in metallurgical industries near New York. The plan considers the delivery of the lectures in the evening or Saturday morning so that young engineers may take advantage of them.

Large Expansion in Electric Steel

The progress made in the electric steel industry of the world was analyzed in an article—"World Electric Steel Output"—in our April issue, pages 126 to 128. The trend for the world, and particularly for Germany and Italy, as compared with 1929 for example, has been decidedly upward. The total world production in 1937, the latest data, was 73.7 per cent larger than in 1929.

Research and the Auto

"One-fourth of all the industrial research laboratories in the country are maintained either by the automobile industry itself or by makers of materials used in motor cars"—T. A. Boyd, head of the fuel department of General Motors Research Laboratories, is thus quoted in an address before a local section of a technical society. To the work of metallurgists, metallurgical and chemical engineers in such laboratories is due, he emphasized, much of the automobile's improvement in appearance, efficiency and lower cost. This has been the trend for a number of years and is continuing.

Non-Ferrous Metals in Autos

In our pages devoted to Current News in this issue will be found an interesting item abstracted from a German source comparing the non-ferrous metals used by auto, truck and bus makers in the United States, England and Germany. A striking fact brought out is the large relative amount of aluminum and magnesium which the Germans are using. This fully confirms other reports. Germany, for example, is using 9 lbs. of magnesium per vehicle, whereas American and English makers are using none. The comparison regarding aluminum is also noteworthy.

World Steel Output

Decidedly downward is the American percentage of the world's steel production in recent years according to data of the American Iron and Steel Institute. In 1884 the United States was credited with 26 per cent of the steel output of the world. In 1929 this had expanded to 48 per cent. It fell to 38 per cent in 1937, a relatively good year and then declined to 27 per cent in 1938, or nearly back to the 1884 level. The depressions have been, of course, the main cause, though expansion in the German industry has been another factor.

Metals and Alloys for Aircraft

Closer agreement on the most suitable metals and alloys as well as the establishing of uniform standards is the tendency among metallurgists in the aircraft industry, particularly among those firms producing engines. The movement has reached the stage of meetings of the metallurgists of such companies but definite results are yet to be attained. Numerous are the ferrous and non-ferrous metals and alloys involved. We were strongly impressed with this fact when we heard recently an address by Fischbeck, chief metallurgist of the Pratt & Whitney Aircraft Corp.

Iron Castings Now Tailor Made

A metallurgical trend of importance is called attention to by A. C. Denison, president, Fulton Foundry & Machine Co., Cleveland. He is quoted as saying that there is a keener understanding by the buyer regarding the physical and metallurgical requirements and possibilities of gray iron castings so that castings are being produced to meet the job as they have never been made before. They are tailor made, so to speak.

Fewer Steel Plant Accidents

If the experience of the second largest American steel company is a criterion, the trend is a fewer accidents in such plants. Operations in 1938 of the Bethlehem Steel Co. were the safest on record. Last year there were fewer accidents per man-hour than in any year in which special accident records have been kept. Accidents have been reduced by 80 per cent since 1916.

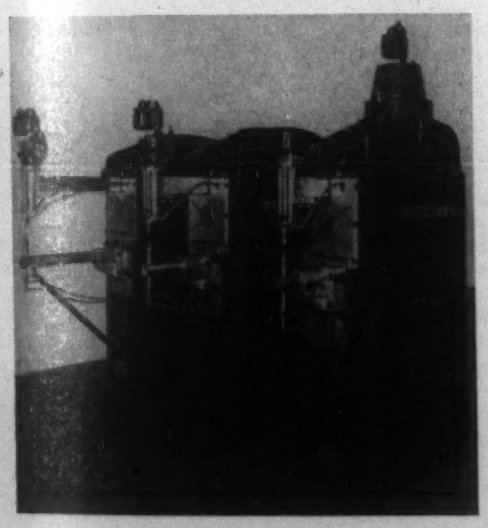
Foreign Demand for Our Alloy Steel

Our exports of alloy steel "ingots, blooms, etc." including stainless, are expanding decidedly this year. For the first two months these shipments have been 4316 gross tons or 2158 tons per month. In 1937 and 1938 the exports of this class of material were 602 and 644 tons per month respectively.

New Equipment and Materials

Multi-Duty Spot Welder

A "Multi-Duty Spot Welder" built around an entirely new design of welding head employing a sliding contact has been announced by Progressive Welder Co., Detroit. The design, which has been subjected to all types of field tests during the past year, is said to permit in the spot welder the elimination of flexible connections in favor of solid arms, the interchangeable use of air-hydraulic or pneumatic boosters for pressure application, a material reduction in current consumption, a vastly widened range of uses due to the more accurate pressure control, use of guns individually or in multiple—mounted vertically, horizontally, or at angles, interchangeable use of 75 to 150 kva and larger transformers, etc.



These features of the new welder are due mainly to the manner of applying both welding pressure and current through a cable-less welding head directly to the welding point. Unrestricted current transmission directly through the gun is made possible by an off-center mounting of the welding point which, under full welding pressure, causes a "cocking" action and forces the gun piston tightly against its cylinder. Experience has shown that scoring of either piston or cylinder even at maximum production speeds or with heavy duty work has been effectively eliminated by the types of metals and lubrication method used.

The design enables mounting the guns on solid arms. In the new welder the gun is mounted on the extreme end of the welding arm. Provision is made for mounting the gun either vertically or at 45-deg. angles. Special adaptors for using guns in multiple—vertically, horizontally or at various angles—or for projection welding are easily installed, it is stated.

Optional pressure systems, consisting of a direct-air unit (which mounts on the upper welding arm) or an air-hydraulic booster unit (mounted in the head of the machine) are available. The elimination of flexible connections, incidentally, is effective in eliminating corrosion normally encountered with such connections. The accurate pressure and current control provided and the absence of shunts permits welding on the one hand of extremely light gage aluminum, and on the other hand of heavy steel sections, formerly considered virtually impossible to spot weld.

Other features of the Multi-Duty spot welder include: Tee-slotted face plate to permit adjustment for welding height and for adapting machine to various types of work; flat welding point seats to prevent distortion and give greater current conductivity; streamlined design eliminating dust and dirt-collecting offsets; a gasket sealed aluminum face plate to prevent scale and dust from being drawn back into transformer windings.

The entire design, it will be noted, is such as to provide maximum salvage value and minimum change-over cost in case the welder is to be shifted to entirely different types of welding operations.

Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts no more than 2 in. wide.

A Castable Refractory

As a result of its recent development work on castable refractories, Johns-Manville, 20 E. 40th St., New York, announces a new "Light Weight Firecrete" for making special refractory shapes, for replacing difficult brick construction, for lining furnace doors, and for making small monolithic linings. The new product is suitable for working temperatures up to 2200 deg. F.

Accepted laboratory and service tests have shown that this latest addition to J-M's line of Firecrete products, widely used by industry for many years, possesses an exceptionally low heat storage capacity. This is of especial importance in intermittently operated furnaces, since appreciable quantities of heat are wasted in heating heavy fire brick and then allowing the furnace to cool. Light Weight Firecrete has been shown to be four times as effective as fire brick in retarding heat, while having only half its weight. Also, its resistance to spalling is such that it will withstand direct exposure to flame temperatures.

Sixty-five pounds of the material are required per cubic foot of finished construction. It can be used to form any required refractory shape. This is accomplished within a short period of time simply by mixing Light Weight Firecrete with water and casting it into a form. Twenty-four hours later the shape is ready to be placed in service.

Light Weight Welding Gun

What is believed to be the lightest "pincher" type welding gun ever offered has been announced by Progressive Welder Co., Detroit. Hydraulic in operation, and designed for welding currents up to 50 kva, and welding pressures up to 1,000 lbs., the new gun is built almost entirely of magnesium. Weighing but a few pounds, the gun may be easily manipulated with one hand, if desired.

As compared with conventional welding guns, an outstanding feature of the new gun, aside from light weight, is the use of the recently perfected sliding contact principle of current transmission. In the new gun, current is transmitted to electrodes directly through the pressure cylinder and piston, the latter being built into the gun. Contributing to the high efficiency of the new gun is the "cocking" action of the piston within the cylinder, increasing with welding pressure, insuring continuous contact of the sliding members and eliminating any tendency to arc.

The sliding principle has another advantage in that, with its use, electrodes travel in a straigh. line toward and away from the work, instead ot the usual arc, thus providing more accurate locating of the spots, and insuring more complete contact of electrode tips with the work. According to the manufacturers, the design has resulted in a considerable increase in electrode life, while improving uniformity of welds. Cooling of the gun is by means of two water circuits. The gun is available in C-type, scissors, yoke, and a variety of special types to fit all pinch type spot welding requirements.

"BBB" Welding Electrodes

Just published is a new Becker Brothers Carbon Co., Cicero, Ill., bulletin giving prices and description of the new and improved "BBB Welding Electrodes." In addition to general operation data concerning grip, length of taper, position of shield, etc., the bulletin also illustrates practical solutions to various welding problems such as replacing a gear tooth, replacing or repairing machine parts and so on.

The new "BBB Welding Electrodes," as stated by the manufacturer, offer better economy since they are considerably slower burning. Arc control is said to be improved with less "wandering" and, since heat is thus intensified at the point of weld, there is less spread of high temperatures to adjacent areas. The makers also claim that the new electrodes stand up better at higher current densities, give increased penetration, and reduce electrode heat at and above the grip by confining it more closely to the welding point.

Electric Control Valve

A self-contained electric control valve for the throttling of gas, oil, or air flow to furnaces, ovens and similar heating applications is offered by Wheelco Instruments Co., Chicago. Some of the features claimed are:

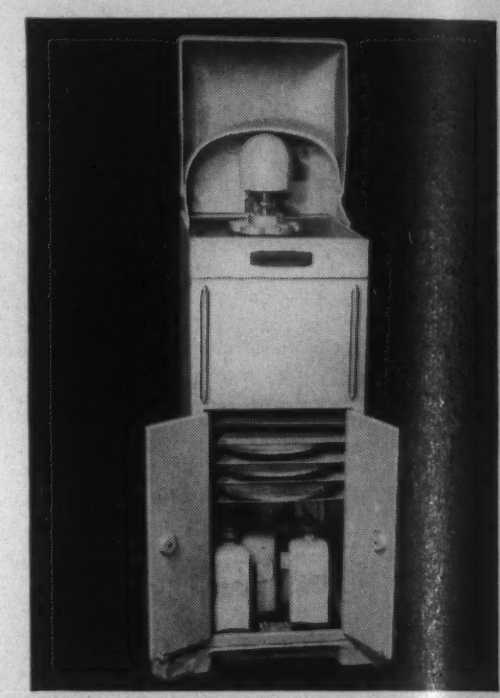
Entirely self-contained, combining valve and valve operator in a simple, totally enclosed unit; no mechanical movement other than the expansion and contraction of operating cylinder; no moving parts exposed; tapered response curve, due to thermal operating principle, minimizes hunting; proportional throttling achieved in a simple and ingenious way in combination with Wheelco Proportioning Controller (No. 211); over-valving corrected without loss of response time by the simple expedient of adjustable rheostat in supply line; screw adjustment for minimum flow; negligible maintenance; and positive, dependable operation.

A Metallographic Polishing Machine

Standardization of polishing technique by means of prepared solutions; almost completely automatic operation which eliminates human error and compensates for inexperience; uniform flatness of finished specimens; low operating speeds to reduce the flow of metal; and a substantial saving in polishing time are features claimed for the new metallographic polishing machine just introduced by Tracy C. Jarrett, Southbridge, Mass.

The Jarrett polishing machine is a single spindle machine involving a new operating principle which permits the polishing of up to six 1¼-in. specimens at the same time. Specimens may be removed at any time during the polishing cycle for inspection, and can be replaced in perfect alignment with the polishing lap.

The Jarrett polishing machine, enclosed in a welded steel cabinet with a hinged hood, consists essentially of a motor-driven lap and a motor-driven specimen holder designed to accommodate a maximum of six specimens. The specimen holder operates from the same motor through an overhanging shaft. It revolves in the same plane as the polishing lap, but in the



opposite direction. The holder is offset from the axis of the lap and is driven by a floating shaft movable vertically to permit inspection and to facilitate the removal of polishing laps.

A simplified universal joint allows the specimen holder to "float" on the surface of the polishing lap and always in the same plane. This free, floating movement of the holder is said to result in unusually flat polished surfaces.

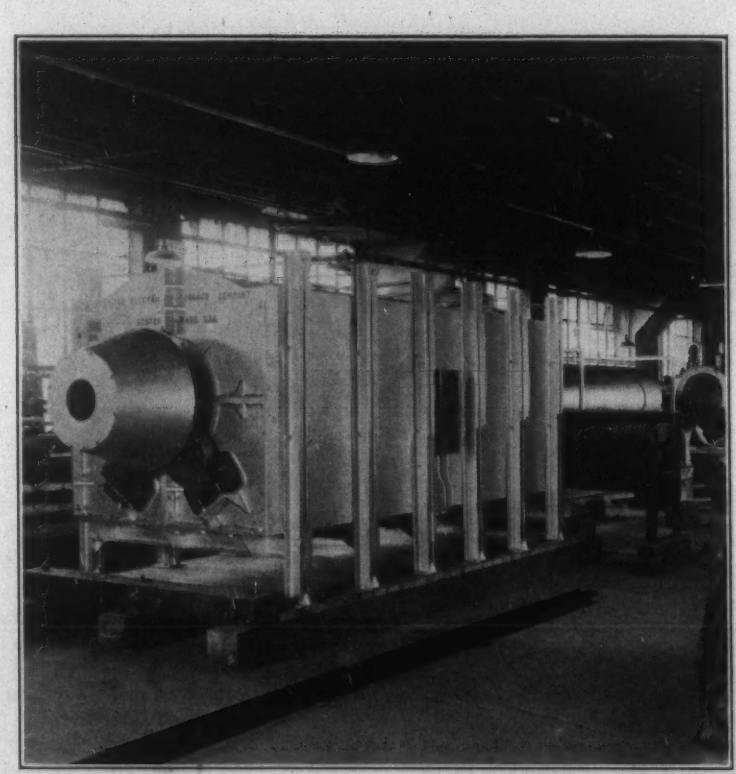
There is a continuous flow of grinding and polishing solutions across the surface of the lap while the machine is in operation. Solutions are fed from a reservoir located on the top of the specimen holder and are agitated by a simple stirring rod while the machine is in motion. This direct flow across the surface of the lap likewise serves to wash away used solutions. Specimens receive a constant supply of fresh solutions.

After mounting in bakelite, the complete grinding and polishing operations are performed by the machine. This is made possible by a series of laps and standardized prepared solutions furnished by the maker.

Using the laps, solutions, and the operating technique established by the maker, it is claimed that the machine will produce specimens of uniform flatness, with comparative freedom from flow of metal, scratches, pits, etc., and will do so in a fraction of the time required to do the same amount of work by hand. The simplified operation guarantees finished specimens of uniformly high quality, even with comparatively unskilled operators. Six specimens can be completely polished within an hour.

Low operating speeds are utilized to reduce the disturbing flow of metal to a minimum. The polishing lap revolves at 172 rpm. and the specimen holder at 170 rpm. The difference in speeds assures that the specimens will be in contact with a different part of the polishing surface at each revolution of the lap.

"AMERICAN" ELECTRIC
CONTINUOUS ROTARY RETORT FURNACES



CRR16108 Rotary Retort Furnace with Cooling Drum and Drive Unit

Retort 16" I.D.x9' long. Cooling Drum 26" I.D.x10' long. 106 K. W. Capacity in excess of 1100 lbs./hr. at 1500° F.

The truly modern furnace unit for production hardening or annealing of steel, brass, or copper.

The complete equipment consists of furnace, internal spiral retort, internal spiral cooling drum, variable speed drive, and automatic temperature control equipment.

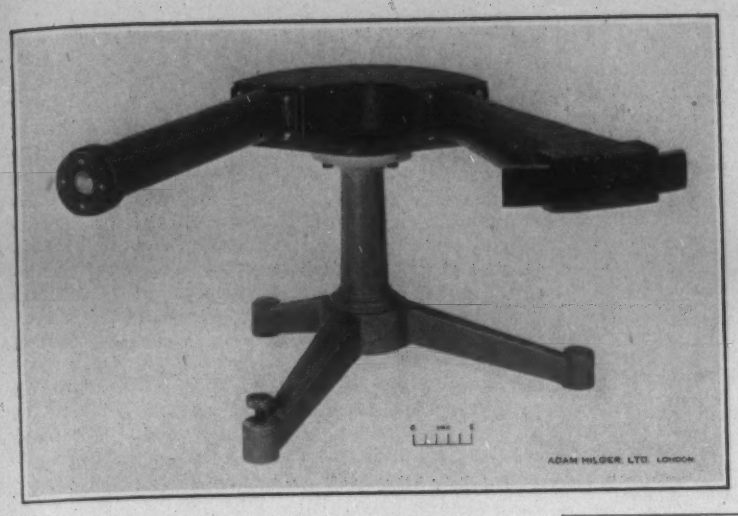
A complete gas cracking unit is furnished when required for bright annealing.

Write for details today.

American Electric Furnace Co.

29 Von Hillern St. **Boston, Mass.**

All types Industrial Furnaces



To Improve Cast Iron

A material which, added to the charge in the cupola, is claimed to decidedly benefit cast iron, is offered by the Metaloid Co., 2306 Union Guardian Bldg., Detroit. It is said that the material provides a method of processing iron to obtain increased tensile strength, toughness, grain refinement and improved machinability. The material is said to reduce the section sensitivity of cast iron, tends to reduce chill and local or general formation of free iron carbide without lowering strength. It also is claimed to provide a fluid, clean metal.

Hydraulic Jack

Rated at 50-ton capacity, the Rochester hydraulic jack is only 6 in. high and has a lift of 2¾ in. In operation, the extended barrel is screwed in until the hardened plunger contacts

the work. Then the long screw with stud end is turned to lift the object. It is made by Rochester Machine Co., Rochester, Pa.

A Spectroscope for Shop Use

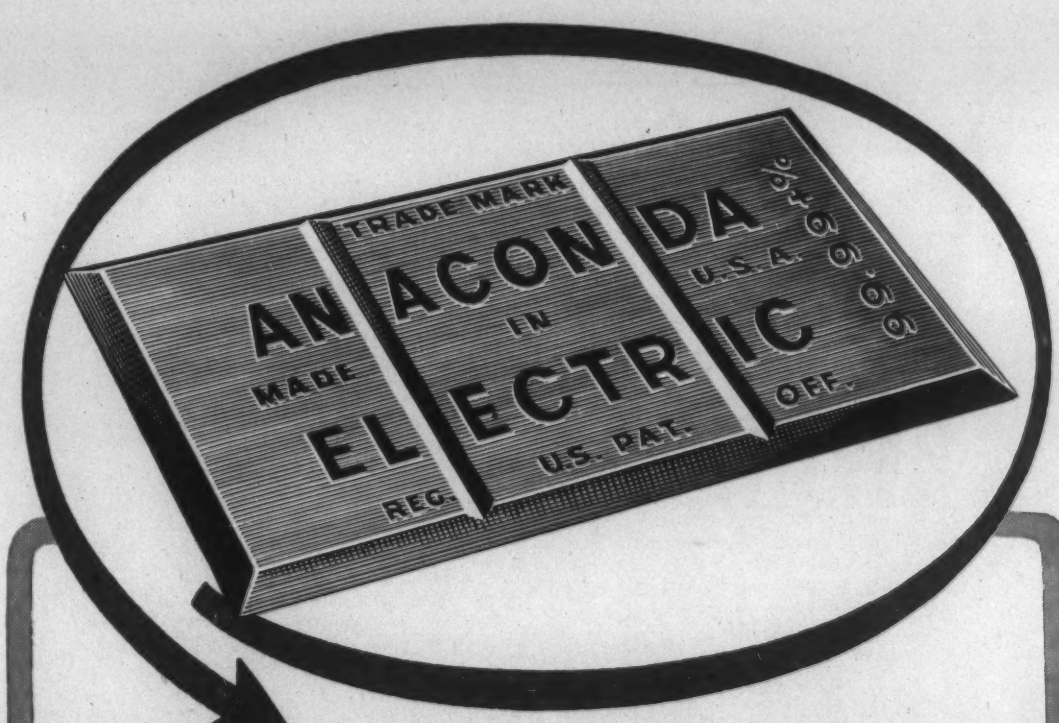
Those who have considered the advantages of spectroscopy—rapid and certain identification or estimation of elements in metals—to be available only to laboratory and scientific workers, will be very much interested in the Spekker Steeloscope, manufactured by Adam Hilger, Ltd., and supplied in America by Jarrell-Ash Co., Boston. This instrument, a specialized spectroscope for the rapid estimation of metallic elements in steel, can be employed for quick reliable sorting and checking of steel stores, purchases and scrap and for general production control. With the instrument even an unskilled observer can detect the presence of significant amounts of nickel, chromium, molybdenum, manganese, titanium, tungsten, cobalt, copper, tin, cadmium and vanadium in tests that require no more than a minute to make. In addition, a few days' experience with bars of known nickel or chromium content, for example, will enable a reasonably intelligent worker to state at a glance the approximate percentage present —1%, 2%, 4%, etc.

In operation, specimens of the steel under examination are made the poles of an electric arc, and the light from this is spread out by the Spekker Steeloscope into a series of lines whose positions are characteristic of the metals present in the specimen. The Spekker Steeloscope has but one movable part, the observation of the various metals being provided for by an eyepiece that can be moved to definite positions indicated by engraved chemical symbols. At each position can be seen the most distinctive spectrum lines of the metal whose symbol is there inscribed. For instance, at "Ni" appear the most distinctive nickel lines and at "Cr" the most distinctive chromium lines. These lines are seen and identified by their position in relation to the always-present iron lines grouped immediately around them, and with the instrument are sent diagrams by the aid of which an observer unfamiliar with the spectrum may find the lines without difficulty.

The apparatus consists of two tubes joined by a metal body. One tube (the collimator) is provided with a glass window directed toward the specimen under observation. Immediately behind the glass window is a narrow slit through which the light from the specimen passes into the Steeloscope, there to be spread out by means of the optical system into its constituent radiations. These, the spectrum lines that reveal the metals present, are seen in the eyepiece in front of the other tube (the telescope). The body contains the prisms that produce the spectrum.

As the slide on which the eyepiece is fitted is moved, it clicks into position at certain places, at each end of which an arrow on the eyepiece slide points to the chemical symbol of a metal. If the metal so indicated is present, one of its distinctive spectrum lines will be seen in the middle of the field of view, when one looks centrally through the eyepiece. The eyepiece has a screw focusing adjustment, by means of which the spectrum lines can be made quite sharp.

Similar visual analysis can be applied to nonferrous materials by means of another instrument, the Barfit Wavelength Spectrometer, available from the same source.



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Fabricating Beryllium Alloys

The Beryllium Corp. of Pennsylvania, Reading, Pa., has announced the completion of new, specially designed facilities for the commercial production of heat-treated beryllium alloys in rod, strip, and wire forms. Hitherto, the company has supplied master alloys only in the ingot and cast form. Now it will be possible to obtain 2-2.25% beryllium-copper, beryllium-cobalt-copper, beryllium-chromium-copper, beryllium-nickel, and other alloys in the primary fabricated shapes.

Manufacturers of electrical devices, small machine parts, springs, aviation instruments, business machines, and other products demanding unique metals will see in this announcement, a wealth of opportunity for product development and improvement. For such products, they have long sought non-ferrous metals with high electrical conductivities and tensile strengths, elastic stability, resistance to fatigue, heat and wear, and uniform hardening characteristics. That the beryllium-copper alloys possessed these desirable properties to an unusual degree has long been recognized.

However, the unique properties of the alloys not only make them desirable but also make them difficult to fabricate into primary shapes with ordinary non-ferrous mill equipment. Up until now, the market has not justified the expense of special equipment and really uniform material has been difficult to obtain. The range of available analyses has been limited and delivery uncertain due to fabricating difficulties. All this has retarded full use of the alloys.

With the new facilities installed at The Beryllium Corporation's Reading, Pa., plant, this disadvantage is eliminated. It is now possible to fabricate rod, strip, and wire under extremely exact laboratory control of all physical properties. From billet to finished strip, every operation is automatically checked and variations eliminated. Much more uniform hardening can be guaranteed and a wide range of beryllium-copper alloys can be supplied.

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CASE HARDENING SALTS

from Du Pont

One or more of the steel treating salts in the extensive du Pont line is just what you need to meet your particular requirements. Du Pont's experienced technical and field staff will gladly help you in selection and economic operation.

Plan to visit the du Pont exhibits at the GOLDEN GATE INTERNATIONAL EXPOSITION in San Francisco—and at the NEW YORK WORLD'S FAIR.

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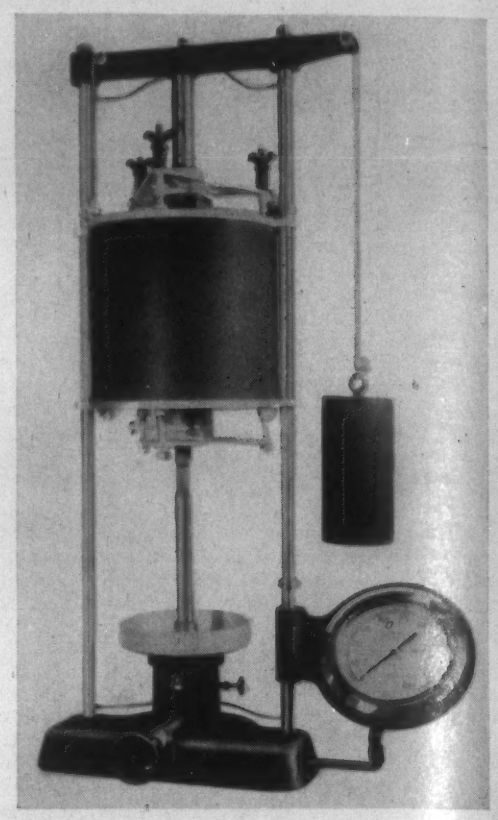
A Dilatometer

The Hitempbond Dilatometer, recently put on the market by the Harry W. Dietert Co., Detroit, measures the behavior of molding and refractory materials at elevated temperatures. "The expansion, contraction, hot strength, hot deformation and rate of collapsibility of molding sands, cores, clays and refractory materials may be readily determined with this practical unit." The Hitempbond Dilatometer consists of three essential parts: A base containing a hydraulic loading mechanism, a furnace which may be readily moved up and down on two vertical posts, and an electrical control unit.

The hydraulic loading mechanism is an oil tight unit, using a screw actuated piston to force oil against a vertical piston. The load



per square inch is recorded on a special test gage with a maximum reading hand. This gage has a machined bourdon tube possessing a high degree of accuracy. A recalibrator screw is located on the face of the dial. The dilatometer may also be furnished with a dead weight beam loading mechanism actuated by motor.

The furnace contains a tubular glotube heating element of long life which completely surrounds the test specimen in the furnace with uniform heat. The furnace is well insulated and may be brought up to a temperature of 3000 deg. F. in approximately 45 min. The electrical terminals on the furnace and supporting posts are water cooled and require a ¼-in. cold water supply line.

The refractory posts in contact with the specimen are made of silicon carbide. Discs of this same material are used to fit against the ends of the specimen. In the strength test an upper disc, with a convex surface, is used to obtain a uniform load distribution on the end of the specimen.

The 1⅛-in. diameter sand specimen is rammed with a special sand rammer equipped with a double end ramming mold. The sand specimen is rammed to the same mold hardness as the A.F.A. standard specimen.

"Dulux"—Enamel for Steel

A new enamel for industrial finishing is announced by the E. I. du Pont de Nemours & Co., Wilmington, Del. Known as Low-Bake "Dulux" enamel, it speeds up production in low-temperature ovens. It affords the following baking schedules: ¼ hr. at 250°F.; ½ hr. at 225°F.; 1 hr. at 200°F.; 2 hrs. at 175°F.

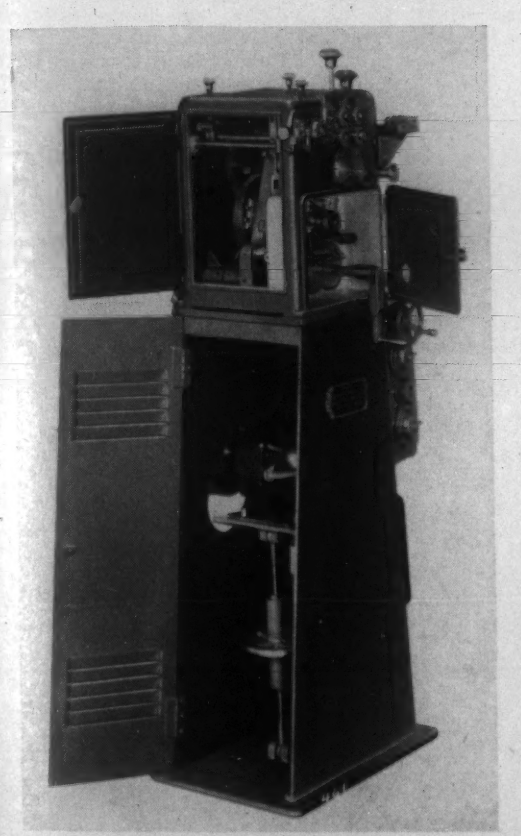
The new finish has demonstrated excellent gloss and build, print resistance, and retained flexibility. It is said to be wrinkle-proof under all normal conditions. It gives satisfactory hiding in one coat when applied on solvent-cleaned steel, bonderited steel or primed steel. White and colors are available.

Universal Segment Type Spring Coiler

"Two hundred springs per minute" (wire diameter 0.004 to 0.028 in.—No. 28) is claimed now possible with the new improved No. 0 Universal Segment Type Spring Coiling Machine, 24-in. Model, designed and manufactured by Sleeper & Hartley, Inc., Worcester, Mass. This machine, with standard equipment, will coil and cut all kinds of compression and extension springs from all size wire from 0.004 up to 0.028 in. dia. Inside diameter of springs is $\frac{1}{32}$ to $\frac{11}{32}$ in. The wire feed may be increased from 24 up to 36 in. on sizes up to 0.02 in. through adaptation of special auxiliary gearing usable only with Variable Speed Transmission Drive.

This model is a greatly improved and more rugged design with many new and exclusive features which include one-piece cast iron housing for rigid and perfect alignment; ball-bearing construction throughout on all rotating shafts; rapid and micrometer adjustment of compound blocks facilitates set-up time; pitch and diameter cam controls readily accessible. Heretofore such control has been adjustable by reaching inside.

As a result of this cabinet-feature, in case of a change or special spring, both pitch and



diameter cams may be shaped, timed, and affixed to the cam hub which, as an entire single unit, may be removed from the shaft without losing the timed relations. One-piece solid cams can be used on this removable cam hub. This model may be had with choice of three types of drive: Motor and variable speed transmission drive; variable speed motor pulley drive; pulley drive (flanged pulley and clutch). The weight of machine is 575 lbs.

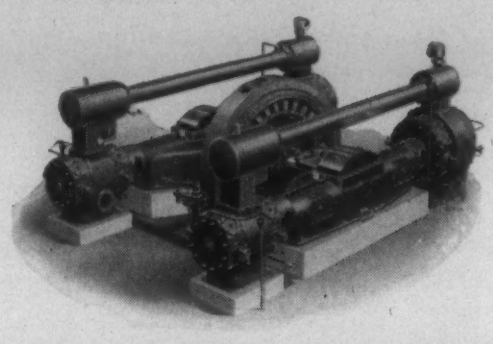
Broaching Solves Fatigue-Crack Problem

The formation of fatigue cracks in piston pins has been virtually eliminated by a well-known automobile company by the simple expedient of finish broaching and burnishing the bores of the wrist-pins. The operation, performed on a Colonial Utility broaching machine of the Colonial Broach Co., Detroit, with hydraulic automatic index table designed for continuous cycle, is exceedingly fast, some 1400 pieces per hour being produced on this single machine.

Three pieces are finished each stroke of the ram, the operator merely loading the indexing table, which indexes an amount equal to three pins for each stroke of the ram. After broaching, the pieces are automatically ejected. The broaching operation eliminated circular tool marks within the bore of the pin, found to be the cause of occasional failure due to the formation of fatigue cracks starting at the tool marks.

LARGE "FOUR CORNER" DIRECT-CONNECTED SYNCHRONOUS-MOTOR-DRIVEN COMPRESSORS

The Ingersoll-Rand line of "Pre" direct-connected synchronous-motor-driven compressors



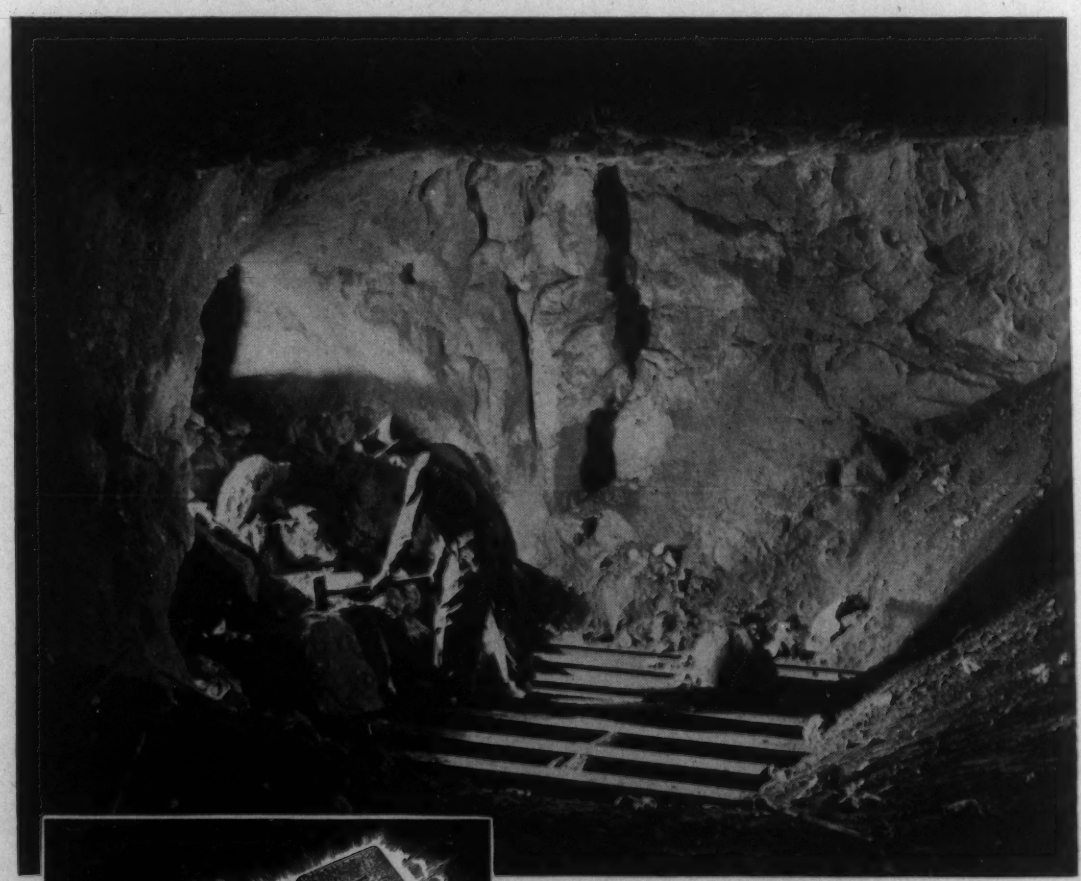
has been further improved by a redesign of the larger four-cylinder units, built in sizes of from 700 to 3000 h.p. These larger compressors feature a "four-corner" construction of two low and two high pressure cylinders having a single motor and a single crankshaft. They now embody a simplified arrangement of cylinders and intercoolers which increases accessibility and efficiency of operation.

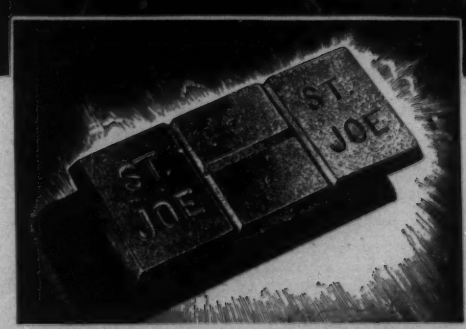
Other improvements include the use of a new "Turret-type" channel valve, which provides greater valve area for the larger cylinders. In addition, the refinements and developments which have been accomplished in over 30 yrs. of manufacturing direct-connected synchronous-motor-driven compressors are incorporated in these "four corner" units.

Detailed information is contained in bulletin 3426-1, copies of which may be obtained from the Ingersoll-Rand Co., 11 Broadway, New York City, or any of their branch offices.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 4 of a Series





At the Bottom of the Stope

In the Balmat zinc mine of the St. Joseph Lead Company the broken ore is screened by a steel "grizzly." The larger boulders have to be broken by sledge or powder. This "grizzly" is the first screening operation. The broken ore drops between the steel beams and falls into the underground ore chute. The miner wears a hard hat to protect his head, safety shoes with steel reinforced toe caps to protect his feet, and goggles for eye protection. He works alone in the sub-drift and his function is to keep the broken ore moving toward the haulage level below

ST. JOSEPH LEAD COMPANY

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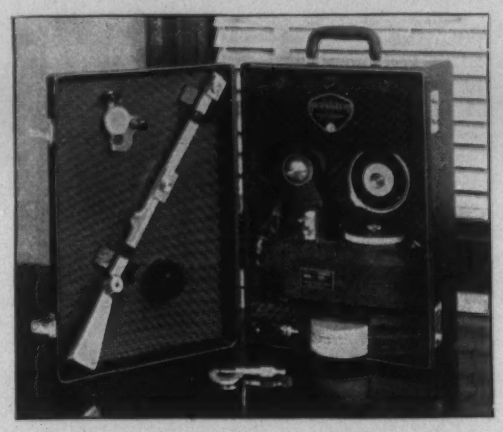
PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Outfit for Testing Wear

The Taber Abraser is a compact precision testing machine for accurately evaluating resistance to rubbing abrasion and is offered by the Taber Instrument Co., N. Tonawanda, N. Y. Its range of application includes practically all painted and lacquered surface finishes, rubber, Durez, Bakelite, Polystrene and similar compounds, vitreous enamels, gold, silver, nickel, chromium electroplate. The Abraser conforms to the best standard accelerated testing practice, as the calibrated wheels alternately cross-rub back and forth over a circular path approximately 2 sq. in. in area, producing a wear action very similar to that occurring under actual service conditions. The wear is continuous and at a practically constant rate due to careful design and coordination of the various factors involved in the test. A powerful dual blower provides cool streams of air for both motor and rotating holder effectively preventing heating of the test specimen.

The end point of the test for coatings is when penetration of the film is first observed, or in the case of solid materials, the test is continued to a depth of .0010 to .0050 in. Accurate measurement of the wear depth to the nearest ten thousandth of an inch is taken with suitable micrometers, and the wear per mil (.0010 in.) calculated.

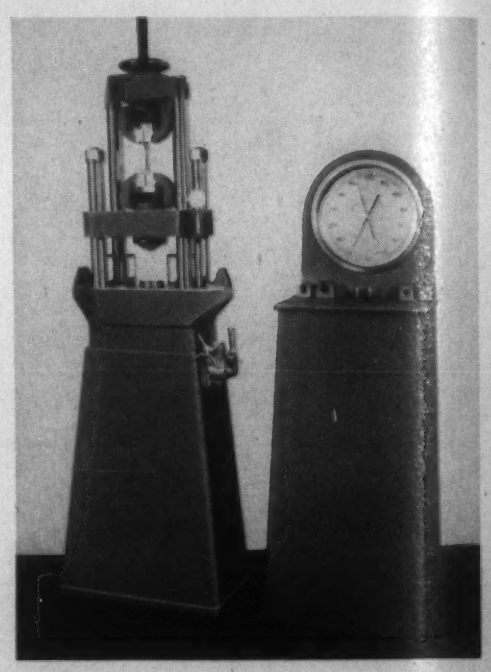


The shear test attachment gives a numerical rating for toughness of organic substances such as paint and lacquer coatings, molded plastics, etc. This test reflects the ability of the surface finish to resist scrapes, digs, cuts and similar damage.

A 60,000-Lb. Universal Testing Machine

The Detroit Testing Machine Co., 5137 Trumbull Ave., Detroit, offers a 60,000-lb. universal tester combining capacity, accuracy, adaptability and compactness at low cost. The load capacity is claimed more than sufficient for all standard specimens and the design is such that the machine may readily be adapted for special purposes. The compression space may be increased and the screw and hand wheel on top of the machine provide adjustment for tensile specimens of different lengths.

The load is applied hydraulically by means of a motor-driven pump. The pump, motor, reservoir, etc., are located in the base of the machine thus being protected against damage. The transverse table, posts, head, etc., are full-floating while tensile testing, eliminating any possibility of misalignment of specimen or friction in the ram. For transverse or compression testing the floating unit is guided in a rigid yet frictionless manner. The change may be made instantly without tools. Ram and cylinder are of the ground, packless type insuring consistently accurate readings. The height overall is about 7 ft., the front width with gage stand is about 5 ft., and the depth is 24 in.



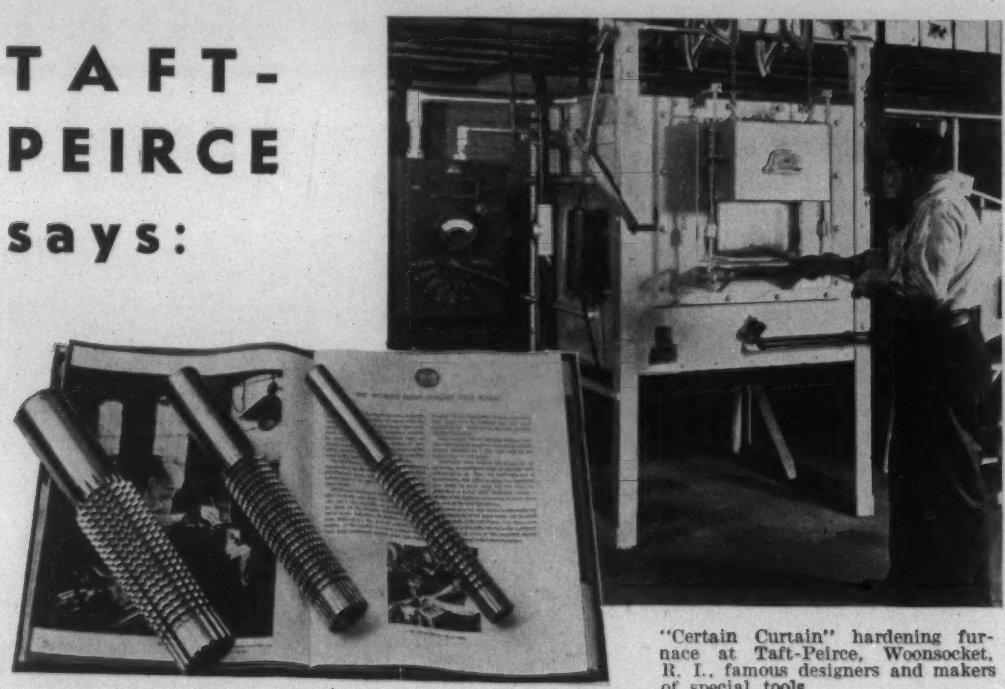
Additional load gauges of different ranges and grips of various types are available to specifications. Similar machines are also made in smaller capacities.

Hood to Ventilate Foundry Equipment

The Claude B. Schneible Co., foundry dust control engineers, 3951 W. Lawrence Ave., Chicago, have introduced the "Uni-Flo Hood" for ventilating shake-outs, knock-outs, gyrating screens, ramming machines, sand conditioning equipment, swing grinders and other exposed dust and fume creating operations in foundries. The Uni-Flo Hood is designed to efficiently collect dust and fumes without interfering with the molds or castings being handled by whatever equipment is being ventilated. Units are designed to operate at various angles and can be installed in a number of positions operating with equal efficiency.

A fan draws the dust and fumes away from the operation and operator. The Uni-Flo Hood spreads this drawing action evenly over a wide surface by means of a relatively small plenum chamber and specially shaped adjustable louvers. Dirty air gathered by the Uni-Flo Hood is collected by the Schneible Multi-Wash Dust and Fume Collector which washes the dust and fumes from the air, using plain water, the dust being reduced to sludge for ready disposal.

TAFT-PEIRCE says:



"Certain Curtain" hardening furnace at Taft-Peirce, Woonsocket, R. I., famous designers and makers of special tools.

"'CERTAIN CURTAIN' keeps tool spoilage down, tool quality UP!"

"When our tool-makers have spent many hours perfecting a set of special tools, like the broaches shown, it is extremely gratifying to know that they will not have to be remade because of hardening mishaps.

"'Certain Curtain' controlled-atmosphere gives complete protection of delicate edges, enabling us to hold high speed steel at hardening temperature amply long to develop the maximum working qualities."

In leading custom tool shops, and in plants making famous brands of cutting tools on a production basis, you will find 1,000 Hayes furnaces keeping spoilage down, quality up! "Certain Curtain" is the outstanding leader among tool furnaces: in number of users and in results produced. Request latest Bulletin. C. I. Hayes, Inc., Est. 1905, Providence, R. I.

5 points explaining "Certain Curtain" leadership

1. "Certain Curtain" performance accepted as The Standard, even by other makers who often claim "as good as 'Certain Curtain'."
2. Through definite savings in tool cost, these furnaces frequently repay their cost in 6 to 18 months.
3. With approximately 1,000 furnaces in the U. S. and 16 foreign countries, "Certain Curtain" is literally the world leader.
4. The patented basic principle of "Certain Curtain" atmosphere control remains unchanged, while scope has greatly widened through adaptation and mechanical refinements.
5. After 11 years, with new methods coming and going, "Certain Curtain" is more firmly established than ever as THE LEADER among controlled-atmosphere furnaces.

ELECTRIC CERTAIN CURTAIN FURNACES

FOR 11 YEARS THE LEADER IN CONTROLLED-ATMOSPHERE HEAT TREATMENT

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JUNE, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

A. H. EMERY, SECTION EDITIOR

2a. Ferrous

New Furnace Follows Modern Design Trends. J. H. SLATER (Republic Steel Corp.) *Iron Steel Engr.*, Vol. 35, Jan. 1939, pp. 63-67. New furnace at Youngstown plant has a hearth diameter of 25 ft. 6 in., bosh 28 ft. 3 in., and stock line 19 ft. 6 in. The hearth is 12 ft. 6 in. high, the bosh is 11 ft. 9 in. high, and the furnace 107 ft. 3 in. The working volume from tuyeres to stock line is 40,100 cu. ft. Iron and slag runners are arranged to use eight 35-ton open top Fe ladles on one side of the cast house and eight 320 cu. ft. slag ladles on the other side. Double skip hoist uses 200 cu. ft. skip buckets, and operates at a speed of 600 ft./minute. Space is provided between large and small bells so that it is possible to accumulate an 85,000 lb. charging unit on the big bell before dumping. The big bell is 45 ft. 5 in. in diameter, allowing an annular clearance of 2 ft. 6½ in. Furnace has 4 uptakes each 4 ft. 6 in. in diameter, which converge into 2 down-comers. Dust content of gas is reduced to 0.25-0.30 grains/ft.^{3} in the wash tower, while the precipitator reduces it to 0.01-.015 grains/ft.^{3} Blast is furnished by existing engines and is heated in 4 two-pass combustion 22 x 97 ft. stoves used on the old furnace. Automatic blast control is provided. The furnace has been operating under a blast volume of 56,000 cu. ft./minute, producing about 825 tons of Fe/day, with a coke rate of 1775 lb./ton of Fe. Blast pressures average about 18 lbs./in.^{2}, while the top temperature runs consistently under 350°. Approximately 85 lbs. of flue dust is produced per ton of Fe. Gas analysis averages 13.8% CO_2, 24.8% CO, 2.2% H, and 59.2% N_2. Slag volume is about 1200 lbs./ton on basic Fe and 1000 lbs. on Bessemer Fe. CBJ (2a)

The Dressing of Iron-poor Ores, in Particular of Roasted Ores of Gutmadingen (Die Verhüttung eisenarmer Erze, insbesondere von geröstetem Gutmadinger Doggererz) A. WILHELMI. *Mitt. Forsch.-Anst. Gutehoffnunghütte, Oberhausen,* Vol. 6, Nov. 1938, pp. 233-249. In smelting some very poor German Fe ores using an acid-slag process roasting the ores before charging them into the blast furnace reduced coke consumption from 1765 to 1418 kg./ton of pig Fe. The C content of pig Fe thus produced is considerably lower than of ordinary Thomas Fe, because the large amount of slag lowers the furnace temperatures. The distribution of S in the slag, pig Fe and in the waste gases and the heat-balance of the process are discussed at length. Ha (2a)

The Influence of Sinter on the Blast Furnace Process. K. V. MESSERLE & B. M. NOSOVITSKII. *Metallurg,* Vol. 13, Nov. 1938, pp. 48-56. In Russian. Practical. Experiments at the Kirov (Ukraine) blast furnaces showed that the addition of up to 58% sinter reduced fuel consumption and increased Fe output. The use of 58% sinter increased Fe output by 30% and reduced the use of coke by 20%. It also permits increase in the air blast volume with a simultaneous decrease of pressure. By using 58% sinter, the air blast was increased by 10% to 2200-2250 m.^{3}/min. while the pressure was 1.2-1.3 atm., a decrease of 0.1 atm. BZK (2a)

The Effect of Chemically Bound Water on Fuel Consumption in the Sintering of Iron Ores (Der Einfluss des chemisch gebundenen Wassers auf den Brennstoffverbrauch bei der Sinterung von Eisenerzen) W. LUYKEN & G. KREMER. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 21, 1938, pp. 303-306. Research. Concentrates of the usual grades of Fe ore gave a better sinter than brown Fe ores or their concentrates. Sinter from the latter was less solid; the former required less coke and left less unsintered residue. Removal of the chemically bound-water from brown ores increases the amount of fuel required. Ha (2a)

Experimental Production of Ordinary Carbon and Carbon-free Ferrosilico-zirconium. G. M. VAINSHTEIN. *Metallurg,* Vol. 13, Sept. 1938, pp. 17-23. In Russian. Research. Ore containing 50.10% ZrO_2, 22.6% SiO_2, 3.8% Fe_2O_3, 16.5% Al_2O_3, 0.18% MgO was reduced (with 25% excess C) without the use of a flux in a 50-70 kw. carbide oven. The reduced product had 35% Zr, 5.5% Si, 4.6% C. The C percentage corresponds to ZrC. A product of 30-45% Zr and only 0.1% C was obtained by the silicothermal process, in which FeSi was used as a reducing agent. BZK (2a)

2b. Non-Ferrous

Electric Smelting with the Westly Furnace. M. SEM. *Eng. Mining J.,* Vol. 140, Jan. 1939, pp. 47-48. Descriptive. A furnace of the Westly type, with a capacity of 2500-kva., has operated continuously for 5 yrs. at Sulitjelma. A flotation concentrate containing 20% Cu is smelted, yielding a matte that is blown to blister Cu in a Bessemer converter. Cu of 99.15% purity is obtained. At Imatra, Finland, a 3-phase furnace of this type, completed in 1936, smelts 240-250 tons of cold charge per day, with power consumption of 500 to 600 kw.-hrs. The 3 Soderberg electrodes are consumed at the rate of 2-3 kgs. per ton. The furnace gas is mixed with that from the Bessemer converters and sulphur dioxide is removed before discharge through the stack. Advantages claimed for the electric smelting of Cu ores are: Economical recovery of S, reasonable power and electrode consumption, low slag and dust loss, and simple and reliable operation. WHB (2b)

New Reverberatory Waste-heat Boiler and Power Plant at Douglas Smelter. L. L. MCDANIEL (Phelps Dodge Corp.) *Metals Tech.,* Vol. 6, Feb. 1939, T.P. 996, 16 pp. Practical. A detailed description of the waste-heat boilers on the Cu smelting furnaces and the power plant at the smelter. The outstanding feature of design is the location of the boilers directly over the skimming end of the furnace, with the boiler tubes exposed to the molten bath in the furnace and with no damper between furnace and boiler. During over 2 yrs. of continuous operation, there has been no reason for altering or modifying this arrangement in any way. Waste-heat recovery has been greater than was ever attained with the conventional design of furnace and boilers separated by flues, while economy of furnace operation has been improved through elimination of brick expense on these flues. JLG (2b)

The Reduction of Tungstic Oxide (WO_3) with Solid Carbon and Hydrogen (Ueber die Reduktion von Wolframoxyd mit festem Kohlenstoff und Wasserstoff) W. BAUKLOH & F. JAEGER. *Z. anorg. allgem. Chem.,* Vol. 239, Nov. 8, 1938, pp. 365-368. Experimental research. Results of a study of graphite and of H reduction of pure WO_3 and mixtures of WO_3 with powdered Fe are given by isothermal curves of per cent reduction against time. The practical beginning of reduction of pure WO_3 using C is around 800° C. and using H around 450° C. In both cases, Fe reduces these temperatures 50°-100° C. HFK (2b)

Pure Zinc—Its Preparation and Some Examples of Influence of Minor Constituents. E. C. TRUESDALE & GERALD EDMUNDS (N. J. Zinc Co.) *Metals Tech.,* Vol. 6, Feb. 1939, T.P. 1033, 11 pp. Review. The method used for making small amounts of very pure Zn by distilling in vacuum is described. The so-called spectrographically pure Zn contains less than 0.0002% Pb and less than 0.00005% Cd. Attention is called to the development of satisfactory Zn-base die-casting alloys made possible by high-purity Zn. JLG (2b)

Viscosity of Slags at Ural Copper Smelters. F. M. LOSKUTOV & G. I. DAMSKAYA. *Tsvetnye Metall.,* No. 9, Sept. 1938, pp. 62-69. In Russian. Research on the viscosity of converter, water-jacket, reverberatory furnace, and some synthetic slags. The viscosity of furnace slags varied from 1.5 to 11.7 poises at 1200° C. Converter slags were the most fluid. The viscosity decreases with increasing CaO and FeO. Increase in SiO_2, Al_2O_3 and ZnO raises the viscosity. The losses of Cu in slag were not due to mechanical entrapment but to the solution of matte in slags rich in CaO and FeO. BND (2b)

3 Melting, Refining and Casting

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Sand Research and Scrap Reduction. *Foundry Trade J.*, Vol. 59, Dec. 29, 1938, pp. 479-482. Review. New sand supplies, examples from practice, enameling troubles, sand for bath molding, sand for venting, synthetic sand and patching difficulties are discussed. Experience with a large variety of molding machines has shown that each type has characteristics that must be recognized, and sand supplies must have properties suited to the machines. By suitable choice of sand conditions, it is possible to produce a bath having the quality of skin desired for enameling with a more open class of sand than is normally used, thereby eliminating entirely, or at least appreciably reducing the amount of artificial venting generally required to ensure a satisfactory casting. By "synthetic sand" is meant a molding sand composed of a silica sand suitably bonded by the addition of some form of clay, generally china clay or one or the other of the highly colloidal clays sold under the names of Colbond and bentonite. China clay is quite effective, but its bonding power is small in comparison with the colloidal clays, and for equal bond it may be taken that some 18% of china clay will be required to give the same green strength as may be obtained with 6% of Colbond or 3-4% of bentonite. The latter is more colloidal than Colbond, and less is required to develop a satisfactory strength, but the Colbond has an advantage in that it has a somewhat higher fusing temperature and is accordingly more refractory. There is, no doubt, a field for synthetic sands, but it cannot be said that they are ever likely to replace the naturally bonded sands in England, where the supply of good-quality molding sands is almost unlimited. It cannot be too strongly emphasized to anyone attempting the use of synthetic sand for the first time that a molding technique must be developed that is different from that employed in the use of the common molding sands. AIK (3)

High-temperature Melting with an Electron Bombardment Furnace. R. HULTGREN (Harvard Univ.) *Ind. Heating*, Vol. 6, Mar. 1939, pp. 203-206. Descriptive. The electron bombardment furnace is used to melt very small quantities of metals of extremely high melting point in a vacuum; the temperatures attainable are limited only by the refractoriness of the crucible; a zirconia crucible will withstand 2500° C. The "furnace" comprises a hot filament placed near a conducting crucible shell in a vacuum. The filament is near ground potential, while the shell is charged to 2200 v. Electrons fly from the hot filament to the shell, striking the latter and liberating their energy as heat. No insulation is used, but there is a radiation shield of Mo surrounding the crucible and filament; the transformation of electrical energy into heat is very nearly perfect. As the crucible heats up, the gas evolved by metal, crucible and shield is pumped off by a high-speed diffusion pump. Metals of high vapor pressure at their melting points cannot be handled in this equipment. In one experiment, a Ta shell was melted (m.p. 5162° F.) with an expenditure of only 700 watts. Ha (3)

Principles of Gating and Feeding. A. M. CAMPBELL. *Foundry Trade J.*, Vol. 59, Nov. 17, 1938, pp. 367-368; Nov. 24, 1938, pp. 383-385. Practical examples in cast Fe and non-ferrous alloys that have been found entirely successful are described. The following fundamentals in gating and rising must be adhered to: (1) One should decide the type of gate that is best suited and most convenient to use on the type of casting, or kind of metal being considered, *i.e.* whether drop gate, bottom-poured gate, or a combination of both. (2) The correct size and shape is of next importance, as they govern the speed of filling. It is suggested that the main gate cross-sectional area should be 50% greater than the total cross-sectional area of the sprays taken from it. (3) In order to ensure clean metal entering the mold, the use of dirt or slag traps may be necessary. Types of gates, application to cast Fe, application to Monel metal, molds for Monel turbine feed pump impeller, gunmetal valve body, gunmetal de-aerator, high-tensile bronze pump casing and high-tensile bronze 3-throw pump and valve box are discussed. Attention is called to the necessity, in non-ferrous work, to arrange for the opening of the gate to avoid turbulence. AIK (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

The Casting of Steel. J. H. ANDREW. *Foundry Trade J.*, Vol. 60, Jan. 19, 1939, pp. 80-81. Review. Experiments on fluidity, gases in steel, iron-sand molds and complexity of cast iron are discussed. The fluidity spiral showed an extraordinary correspondence between the points on the liquidus curve and the changes in the solidus region, indicating that the solid state is in some way dependent upon the liquid state from which it is formed. This in itself suggests that in the near future metallurgists will have to study the constitution of the liquid state. The reason foundrymen find what they imagine to be large differences in fluidity under different conditions of melting, may be either the evolution of gases, or the actual gas content of the steel in question. The author has been carrying out some interesting experiments using, instead of ordinary molding sand, a composition composed of Fe filings or small turnings mixed with just sufficient sand to bind them together. A strong mold could be made with material containing as much as 90% of turnings, which acted as a mild chill, producing in certain irons a white condition, whereas under normal sand casting that iron would be gray. If a more conducting metal, such as Cu or Al, is used, the chill produced is even greater. It is well known that carbide-forming elements, such as Cr, do retain C in the combined state; but why Ni, which is a γ-retaining element, should also act as a graphitizer is not easy to understand, unless it be that Ni forms, at high temperatures, a carbide that breaks down on cooling. AIK (3a)

Lead in Cast Iron (Blei im Gusseisen) H. BRUHN. *Doctor's Thesis, Tech. Hochschule Aachen*, 1938, 23 pp. Original research. A chance observation in a roll foundry indicated that the hardening depth of chilled iron is changed by Pb. As, however, contradictory results were obtained, a systematic investigation was made; this showed that in castings coming from open-hearth, Siegerland reverberatory furnaces and electric furnaces, Pb increases hardening depth, while in cupola Fe a reduction was observed. The absence of any effect at all was found only in Fe from the reverberatory furnace. The cause of this different effect of Pb is believed to lie in the residues present in the Fe, such as oxides and alloying elements. The state in which the non-metallic inclusions are present changes the specific character of a melt, as they are not always stable but show different stages during the melting process. According to the stage, the effect of a Pb addition is constantly changing, as stated before. If cast iron is expected to solidify in the most natural manner, such submicroscopic inclusions should—by correct melting procedure—be brought to a certain stable condition. Pb acts then only as a reagent and indicates by its effects whether such a stabilized condition has been obtained. 17 references. Ha (3a)

Small Ingots—Manufacture in the Basic Electric Furnace. DOUGLAS V. HAMILTON. *Can. Metals Met. Inds.*, Vol. 2, Feb. 1939, pp. 27-29, 33. Practical. A furnace of the improved Heroult type permits taps of 5-ton heats at 2-hr. intervals. The furnace is in use at the Montreal plant of the Canadian Tube & Steel Products, Ltd. The side-wall linings are made of magnesite brick to the slag line or to 4-6 in. above it, with the remainder consisting of silica brick. Silica brick is used in roof construction. The furnace shell is of cylindrical form with spheroidal bottom and roof. Three graphite electrodes in triangular formation are lowered through the roof. The voltage ranges from 90 to 150 v. across the electrodes. The operation of the furnace is outlined, as well as the tapping and deoxidation. WHB (3a)

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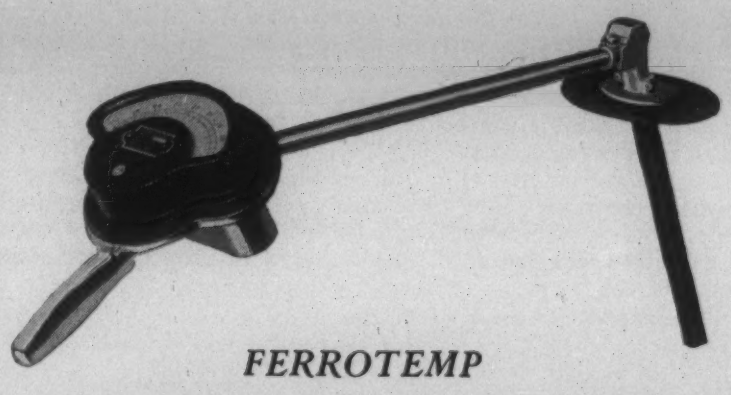

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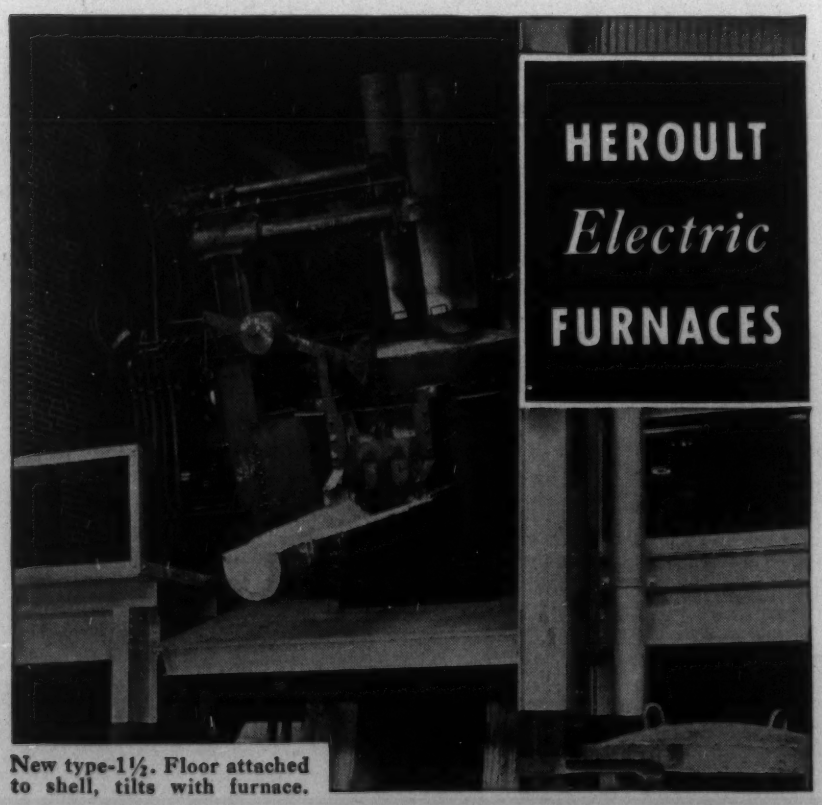

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UNITED STATES STEEL

Gases in Ferrous Materials. H. ELLISS. *Iron Steel Ind.*, Vol. 12, Nov. 1938, pp. 168-173. Original research. Acid O.H. and crucible steels were melted *in vacuo* and subsequently under atmospheres of H_2, N_2 and CO. Graphs are included for results of physical testing. Sound ingots were made by adjusting an induction melting coil in such a position that the top portion of the ingot was kept molten, thus feeding the ingot while the current was gradually diminished and the hot top cooled slowly. High loss of C in low-C steels was experienced, owing to a larger amount of O_2 present, but there was a low loss in the higher C varieties. Loss of Mn followed the same trend. Losses were heavier in O.H. steels, owing to differences in purity of original stock, furnace atmosphere and general melting conditions. Mn was due in large part to volatilization. Vacuum melting produces a large fall in yield point, owing to gas removal. Even with low Mn contents, melting in CO restored the yield point to as-received values by restoration of O_2 content. Presence of O_2, N_2 and H_2 all serve to increase maximum stress to the as-received values and cause marked increase in hardness. Increase in brittleness was also noted, owing to O_2 and H_2 in steel, while nitride needles produce an effect according to their orientation. Nitriding increases wear resistance, but the presence of oxide inclusions and nitride needles lowers fatigue resistance by acting as stress raisers. HFT (3a)

Refining Cast Iron. G. S. EVANS. *Foundry Trade J.*, Vol. 60, Jan. 26, 1939, pp. 99-101. Practical. Mixtures of soda ash and other chemicals were used for treating molten cast iron in the ladle in England as early as 1860. However, the practice was not generally adopted at that time. Desulphurizing seems to have been completely forgotten during the next 50 or 60 years. The excess of cheap scrap, coupled with the poor quality of coke available to foundries following the War, caused a revival of interest in the subject, both in Germany and in the United States. Development of continuous process, chemical reactions with soda slags, activity at cupola temperatures, desulphurizing in cupola, soda ash in ladle treatment, effect upon physical properties, etc. are discussed. In the cupola, soda ash acts in 2 ways to produce cleaner castings: (1) It increases the fluidity and activity of the slag; (2) it acts as a catalyst in accelerating the combustion reactions. However, where it is desired to use high scrap mixtures in the production of castings that require machining, or where S must be held within specified limits, the combined use of small quantities in the cupola, coupled with desulphurizing in a teapot mixer ladle, is generally to be preferred. AIK (3a)

Forehearths—Advantages of Conventional Forehearth and Teapot Ladle. *Can. Metals Met. Inds.*, Vol. 2, Feb. 1939, pp. 30-31, 38. A resumé of papers by John Thwaites and Hugh Davis and dealing with forehearths and the teapot ladle, respectively. Correct cupola forehearth design requires that the diameter of the hearth should be approximately the same as that of the cupola at the melting zone, with larger capacity procured, when needed, in hearth diameter rather than in depth. There should be a minimum of brick and a maximum amount of insulation, consistent with good design. Advantages claimed for the teapot ladle are: (1) Better mixing of the metal, (2) the provision of sufficient time for the Fe to get rid of entrapped impurities, (3) a closer approach to continuous pouring is achieved, resulting in hot metal, (4) there is an opportunity to chemically treat the metal for elimination of S and oxides, (5) the removal of S and oxides leads to better machinability, and (6) the good refining program that can be carried out in the ladle allows for an increase in scrap additions. WHB (3a)

Production of "MS" Non-aging Steel. M. GERSHGORN & R. POPOV. *Stal*, Vol. 8, Aug.-Sept. 1938, pp. 31-38. In Russian. Plant research. Steel containing 0.15-0.25% C, 1.2-1.6% Mn, 0.2-0.4% Si and 0.3-0.4% Cu was deoxidized (a) by addition of ferro-aluminum (6.7% Al) in the furnace and ingot Al in the ladle, (b) with an alloy containing 4.5% Al, 9.0% Mn and 6% Si in the furnace and ingot Al in the ladle, and (c) with ferromanganese in the furnace and ferro-silicon in the ladle. Steel deoxidized according to (a) or (b) had higher mechanical properties, particularly impact resistance, than that deoxidized according to (c). After aging for 2 hrs. at 250° C., the decrease in impact resistance was much less for (a) and (b) than for (c). HWR (3a)

The Role of Magnesia and Its Relation to the Iron Oxide in the Basic Open-hearth Slag. V. V. LAPIN. *Metallurg*, Vol. 13, Nov. 1938, pp. 68-71. In Russian. Research. A petrographic examination of basic open-hearth slag in the course of the process showed that magnesia in the slags of the dephosphorization and boil period may reach and even exceed 30%, and that it is present in the free state (periclase) and not as the silicate. The presence of such a large number of periclase grains increases the viscosity of the slag. The FeO is in the periclase, in the form of a solid solution, in amounts of 2.5-78% by weight. A curve was constructed, showing the relationship between the refraction of the periclase and the FeO:MgO ratio in the slag. BZK (3a)

G. L. CRAIG, SECTION EDITOR

Non-ferrous Foundry Practice. XVIII. Aluminum Bronze. Part II. J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 54, Feb. 3, 1939, pp. 159-163. Practical. Zn content of Al-bronze should be held as low as possible, although up to 0.5% probably does no harm. The presence of Pb or Si is harmful to mechanical quality, although 1-2% Pb is sometimes added to improve machinability and increase wear resistance. Fe reduces the grain size and prevents self annealing, but does increase the strength and fatigue resistance. Ni has a similar grain refining tendency; the strength and hardness is greatly increased, with corresponding reduction in ductility. By use of Fe and Ni in Al-bronze, it is possible to obtain as-cast strength equivalent to the values obtained from the straight Cu-Al alloys by hot-working. The most difficult problem in the founding of Al-bronze is the prevention of oxide formation on the metal in the mold. The most successful practice with these alloys is a combination of steel and Al foundry methods, plus the special precautions necessary to fill the molds with complete absence of turbulence. The solid shrinkage of Al-bronze is rather high but the alloys are comparatively free from hot shortness below 900° C., so that little trouble arises from this cause. In gating, a liberal supply of dross sumps must be supplied. In a thick wall of small diameter, the region of maximum flow will be nearer the inner surface, while in a thin wall of large diameter, it may be near the center. Such an effect has an important practical consequence. Any serious turbulence may cause local concentrations of oxides. Thus, castings of the cylindrical type will usually require a greater machining allowance on the outside than on the inside diameter. Chills must be used on all heavy sections that cannot be fed by suitable risers. The optimum casting temperature varies with composition. The general rule is to cast as near to the bottom of the temperature range as the design will permit. The furnace must enable one to obtain rapid melting. Cu is melted first and the Al added in the form of 50-50 Al-Cu pig. When used, Fe or Ni should be added with the Cu. For Part XVII, see *Metals and Alloys,* Vol. 10, May 1939, p. MA 269 R 4.
RWB (3b)

The Volume Changes of Al, Al-Cu and Al-Si Alloys during Solidification. T. TAKASE. *Nippon Kinzoku Gakkai-Si,* Vol. 3, Feb. 1939, pp. 53-59. In Japanese. Original research. The volume shrinkage during solidification of Al is 6.21%. Among Al-Cu alloys, the 94.4% Al alloy has the maximum shrinkage (6.57%), which gradually decreases with decreasing Al content, the shrinkage at the eutectic composition (67% Al) and at that of $CuAl_2$ (45.9% Al) being 4.44% and 3.12% respectively. In Al-Si alloys, the 98.3% Al alloy has the maximum shrinkage (6.4%), which rapidly decreases with decreasing Al to 3.39% at 88% Al, and to zero at 74.5% Al; alloys richer in Si than the last mentioned alloy expand during solidification. The theoretical expansion of Si alone during solidification at 577° is (by calculation) 13.6%.
NS (3b)

The Solubility of Hydrogen in Aluminum and Some of Its Alloys (Die Wasserstofflöslichkeit von Aluminium und einigen Aluminiumlegierungen) W. BAUKLOH & F. OESTERLEN. *Z. Metallkunde,* Vol. 30, Nov. 1938, pp. 386-389. Experimental. Solubilities were determined from 500° to 900° C. at atmospheric pressure. In pure Al no solid solubility was found. In the liquid, the solubility is decreased by up to 14% of Cu. This effect is not linear, a minimum of solubility occurring at 6% Cu. Si also decreases the solubility with a minimum at 7% Si. Some solid solubility results from the additions of Mn or Ni, but in the melt they decrease the solubility for most compositions. Additions of Mg increase the solubility in both solid and liquid phases, the maximum solubility occurring with additions of 6% Mg.
GD (3b)

Brass for Pressure Castings. N. K. B. PATCH. *Foundry,* Vol. 66, Dec. 1938, pp. 34, 86. Practical discussion of brass alloys recently developed for pressure castings. Plumbing goods manufacturers are using leaded red brass, which consists of 78% Cu, 2% Sn, 10% Pb and 10% Zn. Each of the compositions may be varied to obtain certain properties. In steam or valve bronze, A.S.T.M. specification B-30-36 and federal specification QQB691, Sn is just under point where δ constituent may develop. Pb does not alloy, except in very small amounts, with Cu. Some valve makers use not only red metal instead of yellow, but Al bronze. Also, substitution of bronzes containing Ni for plain brasses is another improvement.
VSP (3b)

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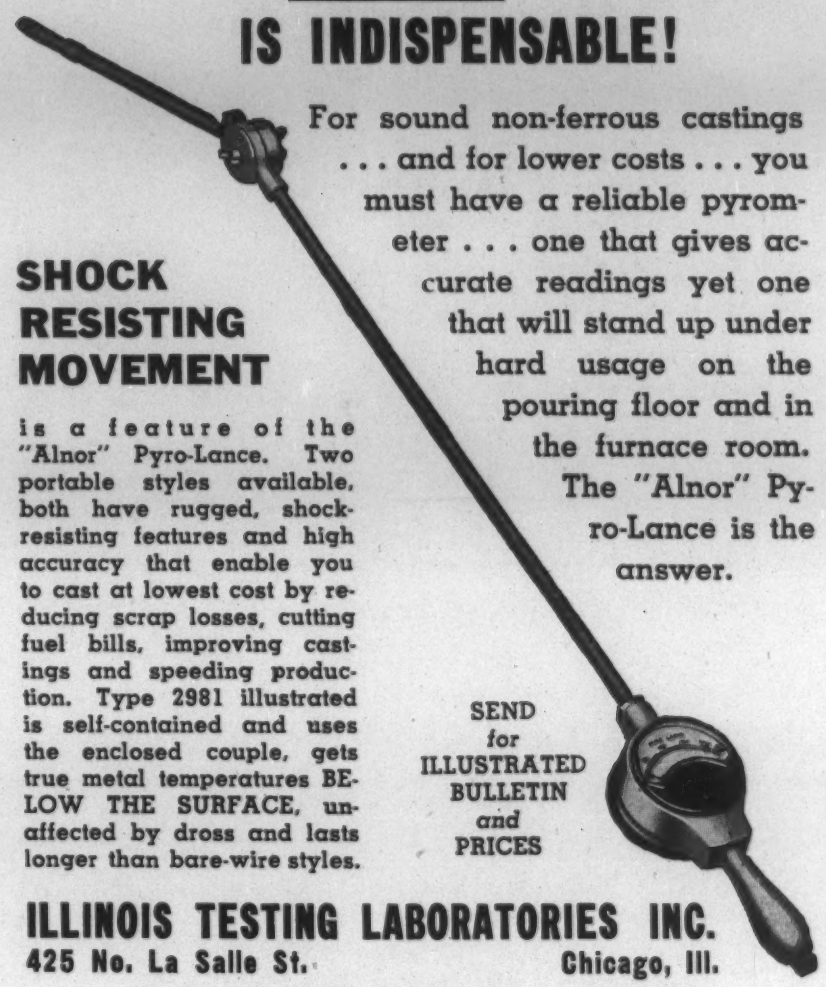

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SECTION EDITORS

The Machining of Non-ferrous Metals. Current Practice and the Trend of Design. FRANCIS W. SHAW. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 57-64. Theory of machining and reasons for the latest developments are given. Machine tools are in a transition stage and, as new cutting materials are developed, the machine design must be revamped to use them. Sharpness is but a relative term. Tools are more or less sharp, but never perfectly sharp. If dull, the edge can neither cut nor cleave; when taking a shallow cut, it can merely rub away or compress the material in front of it. It will begin to remove chips when the cut is sufficiently deep to secure a foot hold. At low speeds, and when the material has a strong affinity for the tool, particles cling to the tool, forming a built up edge. Increase in speed or change in tool angle will overcome this. The function of the edge, however, is not insignificant, for the sharper it is the closer will be the shear surface or cleft to the final surface and, therefore, the work done in compressing and planishing will induce less abrasion, both of the end of the tool and the work material. Tools capable of cutting at higher speed are themselves more resistant to abrasion. The area of the cut is usually less and the chips therefore weaker. Chips abrade the hardest tool, cratering its face, until the crater encroaches on the cutting edge and weakens it so much that it ultimately snaps or breaks. High speed steel tools suffer most from cratering. Chips of Cu, Al and Mg alloys, capable of being machined at high speeds, are the softest of all non-ferrous chips. Friction is the cause of cratering. The obvious way to smooth the chips' course is to diminish the asperities on the tool's surface and to use oil liberally. Addition of colloidal graphite to a mineral oil leads to a smoother surface finish and reduces tool wear. Cr-plating increases the tool life. Control of chip flow to prevent chip curling is very beneficial. The major stress on a tool is the result of initial onslaught, and tools suffer most when they meet the work directly, as in planing and straight milling. Tools for ductile material, such as Cu, can have a more acute cleaving angle. The clearance and planishing angles are determined by the elasticity of the tooled material and, in turning, by the feed angle. The best cleaving angle is the smallest at which sufficient tool endurance is obtained and at which the chip flow is as circumstances allow or compel—necessity for chip breakage. The best clearance angle is that at which the tool point can best burrow into the material. The best planishing and trailing angles are those that leave the surface smoothest with the least work hardening. There is but one best set of angles for a particular job, but small departures from these have little influence on the tool performance. Despite every improvement in cutting materials, broaching technique remains substantially where it was in its infancy; neither the feed per tooth nor the cutting speed have materially advanced. Speed increases have not necessitated strengthening of the stress-bearing elements, but, in general, have reduced the demands. The real problem is to reduce vibration. This is done by use of materials with higher modulus and damping capacity, such as Ni cast Fe and Ni mild steels. Unless all rotating stress-bearing parts run at proportionally higher speeds, they must be strengthened. The trend is to fuller utilization of sintered carbides in tools. Efforts are being made to embrittle non-ferrous chips. A few of the newer machines are described. If machines are designed to cover all materials, they will be too cumbersome and slow for soft materials and too fast and weak to deal efficiently with hard materials. This view suggests that of each type of machine there should be at least 2 varieties, one adapted for ferrous materials and the other for non-ferrous. 8 references. RWB (G-4)

Studies of Die Shape for Metal Drawing. HIROSHI YAMANOUTI. *Trans. Soc. Mech. Eng., Japan,* Vol. 4, Aug. 1938, pp. 258-282. In Japanese, English abstract p. S44. Original research. The author made a die with a curve equivalent to the shape of the locally contracted part in tensile test pieces. The drawing experiments were made with 4 kinds of such dies and 3 kinds of cone dies with the half-die-angle of 4°, 8° and 12° at various stages of reduction of area. The following materials were used: 0.12-0.8% C steels, Cu and Al. The drawing force at each stage of reduction was determined; the change of the mechanical properties of each material in the as-drawn condition were also tested by various methods. The experimental results tend to prove that a heightening of regularity of flow has taken place in the curved die. But with greater contact angles, the stresses are severely localized resulting in tearing and shearing in the center, and causing cuppy fractures. The state of flow of viscous fluids in 2 dimensional models representing several die shapes was studied. The curved die has shown the better distribution of velocity of flow. The half angle of the curved die at the first contact with the metal being drawn at which the greatest efficiency is obtained is generally between 6° and 12°. The optimum angle becomes smaller as the reduction decreases (less than about 15-20% reduction) and, conversely, is greater in heavier drafts. In the as-drawn condition, the metal drawn in the curved die was found to be less brittle than that drawn in the cone die. EF (D-4)

Energy Requirements and Flow of Material in Die Forging (Arbeitsbedarf und Werkstoffluss beim Schmieden im Gesenk) A. POMP, TH. MÜNKER & W. LUEG. *Mitt. Kaiser Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 20, 1938, pp. 265-291. Research. The process of forming a plastic body into shape by pressing or by hammering is investigated as dependent on the kind of die, nature of material and speed of deformation. The testing methods are described in their different stages and results, as well as the specially developed measuring devices with as little mass as possible. Temperature changes of the dies and different starting temperatures of the material influence only the amount of energy required but not the depth to which a material can be pressed into a vertical hole. Samples of Pb and C steel (0.07% C) behaved fully alike in this respect, the steel being worked between 800°-1200° C.; below the γ-α transformation, of course, the increase in resistance to deformation reduces the depth. A result common for all hammer and press tests was that the hammer required for the same deformation 1.8 times more power than the press; the pressure-path diagram indicates, for both processes, a short period of intensive flow. 15 references. Ha (D-4)

Recrystallization Phenomena in Working Al-Cu-Mg Sheets (Rekristallisationserscheinungen bei Verarbeitung von Al-Cu-Mg-Blechen) E. LAY & A. GRIMM. *Aluminium,* Vol. 20, Dec. 1938, pp. 859-865. Research. When drawing or rolling is done under simultaneous tension, as in some sheet-forming processes, the danger of coarse grain formation exists because of repeated intermediary annealing. This gives a rough surface and may even result in cracks during the operation. The investigation of the factors leading to the coarse grain shows that the tendency for this formation can be diminished by trying to obtain a certain grain size in rolling the sheet so that in the later forming process (stretch-tension) the "critical" range is quickly passed. The suitable grain size depends on the amount of the last reduction before annealing and the rate of heating in the annealing process. Diagrams and micrographs of structures illustrate the effect of these factors on grain size and strength. 4 references. Ha (D-4)

Forging of Light and Heavy Metal. Dies of Light and Heavy Metal (Schmieden von Leicht- und Schwermetall. Gesenke von Leicht- und Schwermetall) BERNHARD PREUSS. *Tech. Zentrablblatt prakt. Metallbearbeit.,* Vol. 48, Aug. 1938, pp. 570-572. Practical. The application of 2 hammers striking simultaneously from opposite direction permits the use of Mg alloy dies in drop forging. A detailed economical calculation for drop forging in a steel and light metal alloy die is carried out. The latter costs 1.3 times more than the steel die, which is 4.35 times as heavy as the Mg-alloy die with reference to the same volume. The Mg-alloy die can be worked more readily and is easier to transport. EF (D-4)

4a. Ferrous

The Influence of Reduction per Pass, Rolling Direction and Roll Diameter on the Deformation and Mechanical Properties of Different Rolled Materials (Der Einfluss von Abnahme, Walzrichtung und Walzendurchmesser auf Verformung und mechanische Eigenschaften von verschiedenen Werkstoffen) H. UNCKEL. *Arch. Eisenhüttenw.*, Vol. 12, Dec. 1938, pp. 277-284. Original research. Specimens of Al, Cu, brass and Fe, inscribed with a square ruled network to indicate the manner of deformation during rolling, were cold-rolled between rolls of different diameter and with heavier and lighter passes. The diameter of rolls had no noticeable effect on the mode of deformation; a few heavy passes gave greater distortion than many light ones. The tensile properties were little affected by the manner of deformation, and aside from the effects of surface and grain size, no influences on the hardness were observable. The deformation of the structure across the section corresponded with the grain size found to form upon recrystallization. The stresses remaining in the rolled specimen were small, and were tensional at the surface. SE (E-4a)

The Development of Rolling Mill Drives (Die Entwicklung der Walzwerksantriebe) *Stahl u. Eisen*, Vol. 59, Feb. 16, 1939, pp. 173-181; 186-196; 196-201. Three articles on specific phases of this general subject are presented. L. ENGEL describes recently developed fast reversible drives run by steam engines. With high pressure steam and improved regulators and lubrication, the steam engines have low installation costs, take less space and have good efficiency. The exhaust steam can be used for heating or for generating current. Fluctuations in pressure are handled by flexible construction of the boiler or by accumulators. M. FISCHER discusses electric drives; the development of the electric drive of a 3-stand sheet-bar mill is described, including speed regulation and synchronous control. H. BAUER, discussing rectifier-controlled drives, gives a description of the rectifier plant for the new rolling mills of the Vereinigte Oberschlesische Hüttenwerke. SE (E-4a)

Reactive Wire Drawing. H. A. STRINGFELLOW. *Wire & Wire Prod.*, Vol. 14, Feb. 1939, pp. 108-109. Practical. The value of applying a back-pull in wire-drawing is discussed and U. S. Patent 2,138,126 described in detail, according to which not a definite back-pull but a fixed ratio, less than unity, between back and forward pull is maintained during drawing. This is said to result in preventing the wire being stressed beyond its elastic limit. The advantages of the method are: It operates with the lowest possible die pressure; the optimum amount of back tension is applied to each increment of wire passing through the die; its produces a wire of superior quality as regards uniformity in hardness, torsion and fatigue resistance; it can be employed with high C, stainless and alloy steels at lower cost; and it does not require special technical knowledge in operation. Ha (D-4a)

New Modes in Rolling Mill Construction (Neue Bauweisen im Walzwerksbau) K. ROSENBAUM. *Stahl u. Eisen*, Vol. 58, Nov. 10, 1938, pp. 1281-1292. Practical. Use of welding, particularly on cranes and roll housings, central lubrication of rolls, new gear drives and bushings for the rolls, are described, and contrasted with the old. Welding gives a decided saving in weight and increased dependability; central lubrication effects a saving in lubricants. The improved gear drives, roll bearings, and couplings, which are illustrated, have given good results. SE (E-4a)

Further Development of Wide Strip Mills (Ueber die weitere Ausgestaltung von Breitbandstrassen) B. QUAST. *Stahl u. Eisen*, Vol. 58, Dec. 15, 1938, pp. 1432-1434. Practical. A 2-pass universal rolling mill is described in which wide-strip is rolled semi-continuously, the strip being returned by rollers for the return pass through the same 3-high universal stand. This has at each side of it an auxiliary 2-high stand. The mill has a smaller initial and operating cost, and takes less space than the usual continuous tandem mill. It also accommodates itself easily to changes in production rate. SE (E-4a)

Further Experiments in the Working of Malleable Cast Iron. JOHN V. MURRAY. *Metallurgia*, Vol. 19, Nov. 1938, pp. 7-10. Original research. With light passes and proper anneals it was possible to cold roll white-heart malleable Fe. More difficulty was encountered in an attempt to hot roll. Cold-worked malleable Fe would have useful industrial applications, for one reason because the mechanical properties are improved. JLG (E-4a)

Roll Kicks and Phenomena in the Cold-rolling Stand at the End of the Pass in the Rolling of Sheet (Ueber Walzenschläge und Vorgänge im Kaltwalzgerüst beim Walzen von Blechen im Augenblick des Stichendes) G. REIMER. *Stahl u. Eisen*, Vol. 59, Feb. 2, 1939, pp. 122-126. Practical. A discussion is presented of roll design and roll springing, showing the conditions with respect to thickness of sheet, amount of reduction, original pressure between the rolls, and pressure reached as the work passes through, that may cause roll-kicks severe enough to produce failure. SE (4a)

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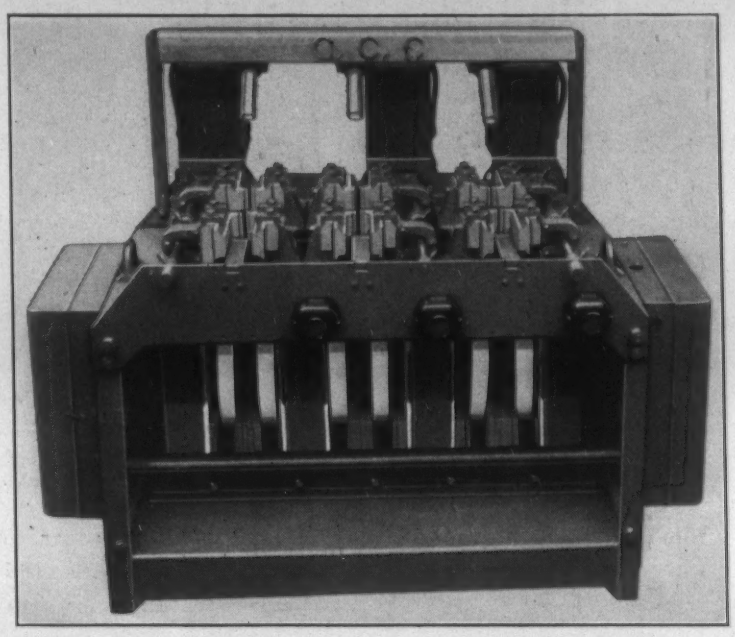

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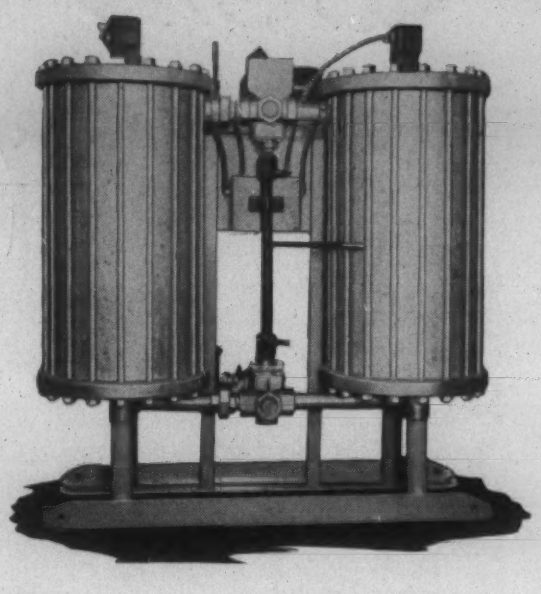

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Resistance to Deformation and Spreading in Rolling and Pressing of Material with Uniform and Non-uniform Hardness across the Section (Formänderungswiderstand (Arbeitsbedarf) und Breitung beim Walzen und Pressen von Werkstoff mit gleichmässiger und ungleichmässiger Querschnittshärte) O. EMICKE & H. BENAD. *Arch. Eisenhüttenw.*, Vol. 12, Feb. 1939, pp. 365-380. Research. In rolling and pressing low C steel, considerable temperature variations between outside and center of the work may be present in the temperature range 850°-1150° C. Pb and Pb-Sb alloys were made up into composite sections to give about the same hardness variations at room temperature as low C steel may have in the temperature range 850°-1150° C. These composite sections were cold-rolled. The amount of spreading and resistance to deformation of these sections was considered to be indicative of what takes place on hot-working low-C steel. The results obtained on the various composite sections are illustrated in 50 graphs. SE (4a)

Fundamental Principles of Steel Wire Metallurgy. B. L. MCCARTHY (Wickwire Spencer Steel Co.) *Wire & Wire Prod.*, Vol. 13, Nov. 1938, pp. 655-664; Dec. 1938, pp. 711-721, 750; Vol. 14, Jan. 1939, pp. 17-25, 79-82. Comprehensive review. Metallurgy of Fe and steel, as applied in particular to wire manufacture, is discussed in detail; the Fe-C equilibrium diagram, structure and its changes by alloying and heat-treating, effect of heating and cooling rates, effect of heat treating on grain size, principles of cold-working and its effects on mechanical and physical properties, and the effects of various alloying elements are explained in detail and abundantly illustrated by tables, curves and micrographs. Ha (D-4a)

The Influence of Sheet Width in the Cold Rolling of Steel Sheets. HORST BOHR. *Iron Steel Ind.*, Vol. 12, Oct. 1938, pp. 5-8. Translated from *Stahl u. Eisen.* See also *Metals and Alloys*, Vol. 10, Jan. 1939, p. MA 22 R/8. HFT (E-4a)

4b. Non-Ferrous

Progress in Impact Extrusion. The Production of Metal Tubes and Containers. W. G. ASKEN. *Metal Ind., London*, Vol. 54, Jan. 13, 1939, pp. 65-68. General. The production of collapsible metal tubes in one operation by the impact extrusion of thick metal blanks has been in use for years. The process consists of placing a slug or blank into a suitably-shaped female die, the diameter of the slug being slightly smaller than the inside diameter of the die, and its thickness suited to the wall length of the finished extrusion. The male die, shaped to conform with the inside of the finished extrusion, is then forced into the slug at high speed. The earliest record of this type of extrusion dates back to 1841 for Sn and Pb. The impact extrusion process is now being applied to: Sn, Sn-Pb, Al, Zn, Cu and brass. Generally speaking, it can be used for the production of shells or cups up to 10 in. long, the diameter varying between 0.5 in. and 5 in., with a wall thickness from about 0.003 in. to 0.045 in. With Al and its alloys, it is necessary to heat the slugs to about 200°-230° C. prior to extrusion. The possible depth of the shell is increased if the Al slugs are in the form of a shallow flat-bottomed cup. With Zn, high purity is essential and the blanks are heated to 200°-250° C. No difficulty is experienced in the impact extrusion of Cu and a process that has been in use for some time, also handles brass. The trouble with brass is that die life is shorter than with the more ductile or softer metals. RWB (D-4b)

The Effect of Drawing on the Hardness and Tensile Strength of Brass Rod. MAURICE COOK & G. K. DUDDRIDGE. *J. Inst. Metals*, Vol. 64, 1939, Advance Copy No. 825, 19 pp. Original research. A detailed study was made of the hardness distribution over the cross-section of typical drawn brass rods from ½ to 2½ in. in diameter. The tensile strength distribution over the cross-section of 1¼ and 2½-in. diameter Mn-bronze rods was also determined. Some observations were made on directional properties and on the effect of cold work on the structure revealed by X-ray examination. In drawn rods, the extent of the hardness variation depends on the size of rod and the degree to which it has been cold drawn. In the larger rods examined, it ranged up to about 50 Vickers diamond pyramid. Irrespective of the condition of the rod, the hardness at a distance of $R/\sqrt{2}$ or 0.7 R from the center was found to be practically the same as the mean hardness of the rod. On a 1¼-in. diameter rod, drawn to an 18.5% reduction, the greatest variation noted in tensile strength was 13,000 lbs./in.^{2}, and on 2½-in. rod, drawn 4.7%, 7,500 lbs./in.^{2} Izod impact values decreased from the center of the rod towards the surface. Tests on specimens cut from 2½-in. diameter rod in both the extruded and drawn conditions showed that the highest values of tensile strength, elongation, and impact were obtained on specimens cut parallel to the axis of the rod, with the lowest values on transverse specimens, and intermediate values on pieces cut at 45°. JLG (D-4b)

Progress in Deep Drawing and Pressing. J. D. JEVONS. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 35-40. Practical review. It is highly significant that drawing and pressing are being considered and conducted more and more as metallurgical operations. There is need for definition of terms in this field as to what constitutes the essential difference between "pressing," "drawing" and "deep drawing." The size and power of presses for shaping sheet metal is increasing, hydraulic actuation is rapidly gaining in popularity; automatic multi-punch presses, both small and large, are finding increased application and a number of refinements, such as automatic lubrication, are now available. Hydraulic presses have undergone radical changes during recent years and their speed of operation is now equal to that of mechanical presses of comparable type, and claims of numerous advantages are made. The use of "soft" metal for forming large shapes in light alloy sheet for aircraft is increasing. Of the more usual tool materials, cast Fe has jumped in popularity, because of the ready availability of alloy irons, which have been known to outlast hardened steel tools. Owing to their efficiency, economy, ease of application and ability to completely cover the surface of the work, "evaporating" type lubricants show much promise. Lubricants containing zinc oxide are proving of great value for severe draws. Difficulty of removal renders unpopular many highly efficient lubricants. Inter-stage annealing is fast becoming a normal routine operation, owing to refined automatic controls. Little recent improvement is noted in brasses for drawing. The fact that most suppliers still fail to furnish brass of uniform grain structure is deplored. The application of pressed Al alloys for aircraft parts is ever increasing. For the pressing of electroplated sheets or articles to leave the plating intact, a more ductile deposit than Cr seems to be essential. The difficulties associated with the specifications and testing of sheet metal destined for drawing or pressing remain unlessened. No universally reliable or truly informative laboratory test has been devised. The recent tendency is to draw heavier gage sheet. RWB (D-4b)

The Milling of Non-ferrous Metals (Das Fräsen von Nichteisen-Metallen) M. GEYER. *Metallwirtschaft,* Vol. 17, Dec. 30, 1938, pp. 1385-1389. Practical. Non-ferrous metals can be divided into 2 groups: (1) Cu and its alloys, and (2) the light metals (Al and Mg) and their alloys. The light metals can be readily milled. Cutter design is quite different from that for Fe and steel, and calls for fewer teeth, greater rake and spiral angle as well as greater clearance for chip removal. Data on the spiral angle, clearance and rake for various type cutters is given for Cu and its alloys, Al and its alloys and Mg. Speed of cutting can be increased by using hard carbide tools. For milling Cu, a cutter speed of 230 ft./min. is most economical for high speed steels, while 440 ft./min. is most economical for hard carbide tools. Cutting speeds for pure Al and Mg are 1500 ft./min. for high speed steel tools and 2500-5000 ft./min. for hard carbide tools. Speed and feeds are given for the various non-ferrous alloys. It is emphasized that tooling up old equipment to machine light metals at high speeds is often unsatisfactory because of lack of rigidity at the high speeds. GA (G-4b)

Machining of Magnesium Alloys; Turning, Planing, Drilling (Spangebende Formung von Magnesiumlegierungen; Drehen, Hobeln, Bohren) E. RAUSCHER. *Maschinenbau Betrieb,* Vol. 17, Nov. 1938, pp. 561-563. Practical. Mg alloys have the following machining properties: The specific cutting pressure is low. A high cutting speed can be chosen because the tools do not become dull quickly. The flow of cuttings is good since they break away easily. The metal tends to coat the tool surface with a metal layer, increasing the friction. The chips should not be too thin because of danger of ignition. Favorable angles on the tools for turning and planing are given. Difficulties during drilling occur unless special attention is paid to the type of drills used and their grinding. Short chips are obtained by small chip angle and steep twist. For deep holes, shallow twist has to be used and a large chip angle is selected. Plenty of feed is advantageous. For drills of large diameters chip breaking notches can be used. Seizing can be avoided by keeping the bevel small and by grinding the tip slightly out of center. RPS (G-4b)

Production Methods in Forming Double Curvature Sections for All Metal Aircraft. A. J. T. EYLES. *Sheet Metal Ind.,* Vol. 13, Jan. 1939, pp. 76-80. Descriptive. Production methods of forming light metals, steel sheets, Elektron metal, etc., for aircraft are given. Since production is relatively small, the question of cheaper dies than steel for forming accurately interchangeable parts is quite important. Rubber pads instead of punches were first used; then Pb or low melting point alloys, such as Cerro. Subsequently Zn dies were introduced, which served as molds for the Pb punches; the difference in expansion produced the necessary clearance that could be controlled for various gages by controlling the pre-heating of the Zn. Lately, cast Elektron dies have been used in drop hammers and power presses; these dies are cast to very accurate dimensions, requiring little finishing, are easy to handle, show extremely little wear, and can be recovered by recasting. JZB (D-4b)

5 Heat Treatment and Heating

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O. E. HARDER, SECTION EDITOR

One Consumer's Problems in Selecting Thermal Insulation. E. T. COPE & W. F. KINNEY (Detroit Edison Co.) *Bull. Am. Soc. Testing Materials,* Jan. 1939, pp. 35-39. Description of the problems that one user of thermal insulation has met and solved in a manner that has been reasonably satisfactory to himself and fair to manufacturers and vendors. This consumer was virtually obliged to solve these problems alone because there are, as yet, no generally accepted specifications or methods of test for ascertaining the suitability of the materials offered for a given service. Certain problems pertaining to the selection of thermal insulation were studied, as a result of which it became apparent that some characteristics are more important than others. The following lists indicate the order of importance, the most important being given first: *Preformed material:* (1) Resistance to deterioration at working temperature, (2) resistance to breakage, (3) thermal conductivity, (4) ease of handling, (5) advantageous disposal of second-hand material. *Unformed material:* (1) Resistance to deterioration at working temperature, (2) absence of caustic alkalinity, (3) trowelability, (4) air-drying shrinkage, (5) thermal conductivity. In order that the producers and the users may find a basis for better understanding, the important step is the establishment of the significance of the physical characteristics for the various kinds and classes of thermal insulation and mutual agreement on methods of test. VVK (5)

Factors Influencing the Thermal Conductivity of Non-metallic Materials. J. B. AUSTIN (U. S. Steel Corp.) *Bull. Am. Soc. Testing Materials,* Jan. 1939, pp. 29-31. Survey. Lack of agreement among the values given in the literature for the thermal conductivity of many non-metallic materials arises from: (1) Absence of a universally accepted standard method of measurement against which other methods can be checked, or a standard sample with which a given apparatus can be calibrated; (2) inadequate or improper characterization of the sample tested. A survey is then made of the following list of factors, which seem likely to have an effect on thermal conductivity, and the influence of a change in each variable when all the others are held sensibly constant is evaluated. The factors that may influence the thermal conductivity of non-metallic materials are: (A) Chemical composition: (1) influence of molecular structure in pure compounds; (2) influence of purity. (B) Physical texture: (1) porosity: (a) total void space, (b) size and shape of pores, (c) size and shape of grains; (2) presence of a vitreous or liquid phase: (a) total amount of phase, (b) distribution of phase; (3) development of bond in fired products: (a) influence of time of firing, (b) influence of temperature of firing; (4) anisotropy and directional effects. (C) Temperature. (D) Pressure, stress or strain. (E) Heat flow. VVK (5)

A Discussion of Test Methods for Determining the Physical Properties of Thermal Insulations. H. H. RINEHART (Johns-Manville Res. Labs.) *Bull. Am. Soc. Testing Materials,* Jan. 1939, pp. 31-35. After a detailed discussion of test methods, supple-

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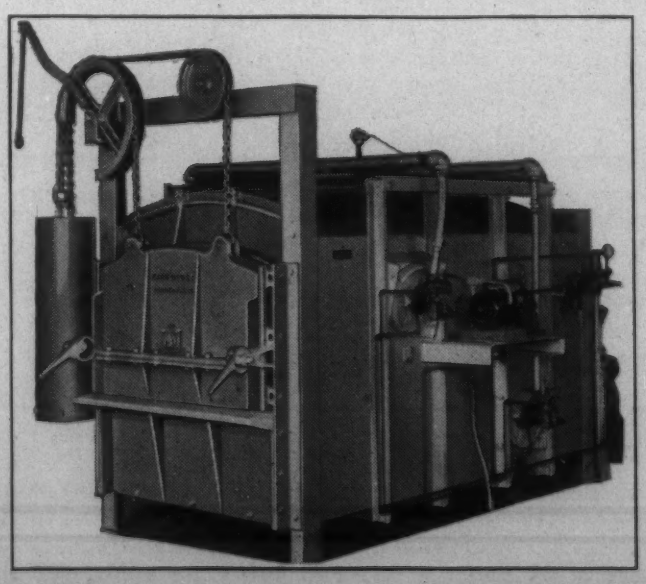

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mented by original data, the author draws his conclusions as follows: It appears desirable to establish standard methods of test for thermal insulations covering the following, some of which apply to plastic insulations and some to preformed: Mixing procedure, preparation of sample for tests, dry molded density expressed as such or as "dry coverage in board feet per 100 lbs. of dry cement," temperature resistance. Thought and study are necessary, both as to the desirability of standards and methods to be employed regarding the following: Consistency, adhesion to steel, cracking and curling, absorption, corrosiveness, hardness, flexural strength, abrasion resistance, toughness, compressive strength, durability. It appears unnecessary to establish standards on the following properties: Loose density, screen analysis, shear strength, tensile strength, porosity, and permeability. VVK (5)

5a. Ferrous

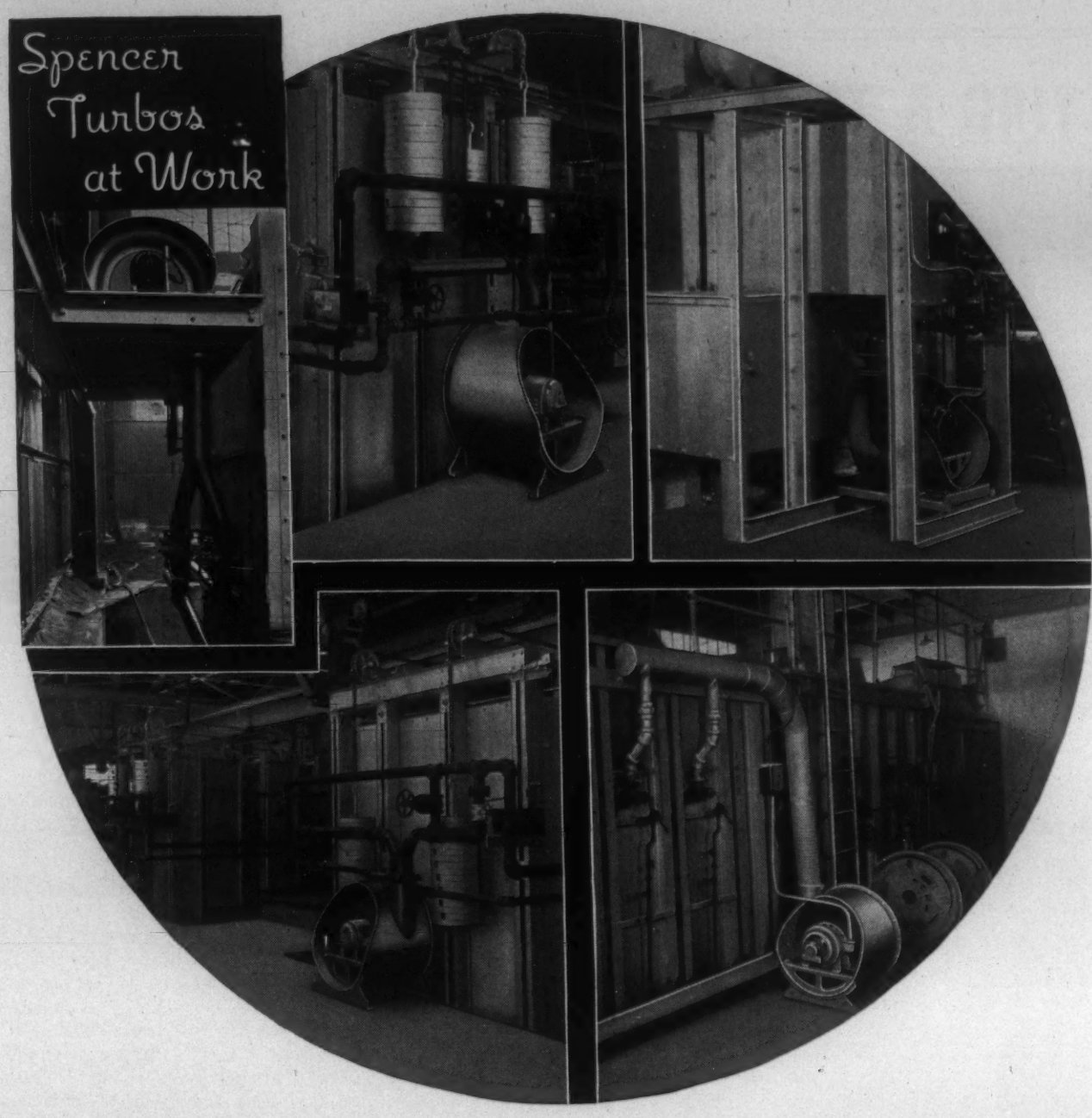
O. E. HARDER, SECTION EDITOR

The Effect of Some Iron-accompanying Elements on the Mechanical Properties of Black-Heart Malleable Iron (Einfluss einiger Eisenbegleiter auf die mechanischen Eigenschaften des Temperschwarzgusses) F. BRÜGGER. *Doctor's Thesis, Tech. Hochschule Aachen,* 1938, 18 pp. Statistical evaluation of 10 years' data, together with metallographic investigation, were used to determine the effect of C, Si, Mn and O. After heat-treatment, malleable Fe can be considered as a steel casting in the basic structure of which temper C is embedded; the basic structure consists of ferrite and pearlite. If Fe carbide is entirely decomposed, the fine structure in the core shows ferrite and temper C exclusively. If samples have the same structure, *i.e.* lie on a line of same structure in the C-Si diagram, tensile strength, elastic limit and elongation increase with decreasing C content, irrespective of the distribution of ferrite and pearlite in the structure. Curves and diagrams show the behavior of samples with different C-Si contents: Si favors precipitation of temper C and carbide disintegration. Mn contents up to 1.5% and an Mn/S ratio greater than 3.5 increases tensile strength and elastic limit and decreases elongation. Increasing O content increases tensile strength slightly; elongation and elastic limit is lowered by it. 16 references. Ha (5a)

Temperature Measurements within the Charge in a Tempering Furnace Heated with Circulating Gases (Temperaturmessungen im Glühstapel eines Anlassofens mit Umwälzgasbeheizung) G. NEUMANN. *Arch. Eisenhüttenw.,* Vol. 12, Jan. 1939, pp. 315-322. Practical. Thermocouple measurements of the temperature were made at various locations within a 3½-ton charge consisting of round bars in a tempering furnace heated with circulating gases. In the first 3 hrs. of heating, temperature differences of over 300° C. were found. After 8 hrs. the greatest difference was 18° C., no further changes occurring with longer heating. The heating period was decreased and more uniform temperature obtained by raising the platform on which the charge is placed so that it could be better heated from beneath and by looser piling of the charge. By decreasing the amount of infiltrated air and improved insulation, fuel consumption was reduced 35%. The furnace was found more efficient and convenient than a Pb bath. SE (5a)

Effect of Aluminum on Plain Carbon Steel (Wirkung von Aluminium im umlegierten Stahl) E. HOUDREMONT & H. SCHRADER. *Arch. Eisenhüttenw.,* Vol. 12, Feb. 1939, pp. 393-404. Original research. In a study of the effect of the addition of up to 2.5% Al to plain C steel of 0.15 to 1.0% C content, the A_3 point was raised with increasing Al content. Despite this and the lack of hysteresis, large Al additions increased the hardenability although small Al additions lowered it. The effect of the lower Al additions was attributed to grain refinement, and of the larger additions to alloying. After experiments in which steel, deoxidized with Al, was remelted in air, vacuum and N, it was concluded that fine grain is caused by Al nitride. Decarburization was decreased by small additions of Al, and increased by large additions. The increased hardenability caused by the addition of large amounts of Al is due to the formation of an Al carbide, and to the taking up of Al by Fe_3C. SE (5a)

Considerations and Experiences in the Building of a Pusher Type Furnace for Alloy Steel (Ueberlegungen und Erfahrungen beim Neubau eines Stossofens für legierten Stahl) KARL V.D. LINDEN. *Stahl u. Eisen,* Vol. 58, Dec. 29, 1938, pp. 1473-1481. Practical. A new pusher type furnace fired with mixed gas and with blast furnace gas for heating alloy steel ingots for rolling is described. The temperature is controlled throughout the length of the furnace. The efficiency was very good, the heat consumption being about 460 K cal./kg. charge and 20,000 K cal./m.² hearth area/hr. The side burners were generally fired with blast furnace gas, mixed gas being used only to increase the output. This generally decreased the scaling, which amounted to from 1 to 3% of the charge, according to the furnace atmosphere, temperature, and heating time. SE (5a)



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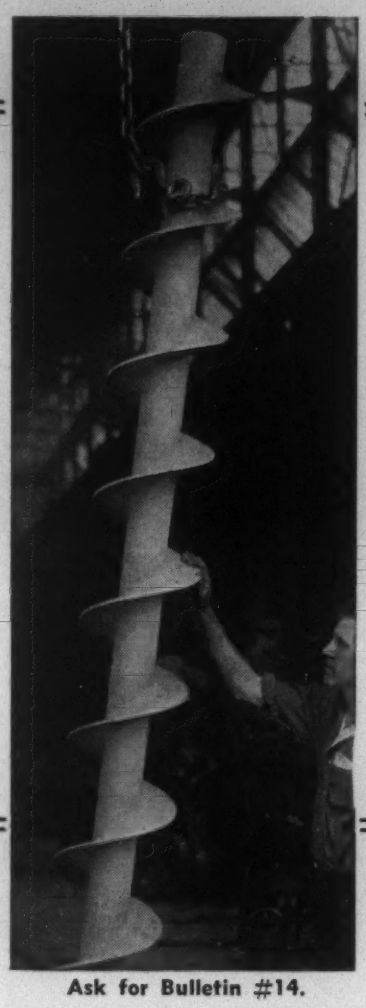

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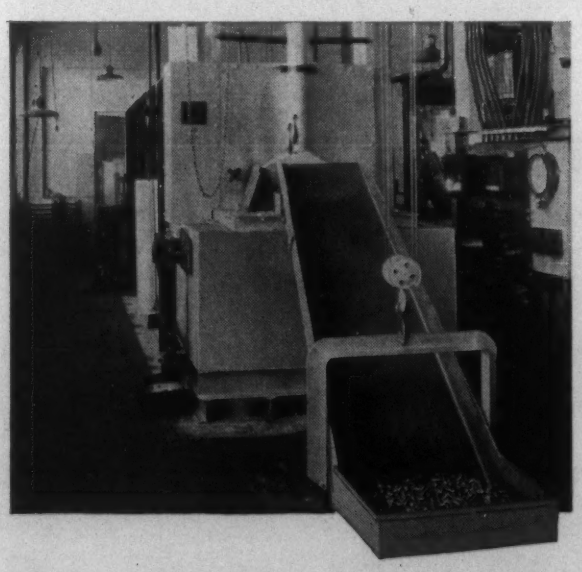

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Decarburization of Carbon Steel by Hydrogen (Der Ablauf der Umsetzung zwischen Wasserstoff und Kohlenstoff im Eisen) W. BAUKLOH & B. KNAPP. *Arch. Eisenhüttenw.*, Vol. 12, Feb. 1939, pp. 405-411. Original research. H removes C from the steel surface according to the reaction $Fe_3C + 2H_2 = 3Fe + CH_4$. For the reaction to continue, H must be able to diffuse inward. At lower temperatures, diffusion is slow and this determines the rate of the reaction so that decarburization is faster the higher the temperature, C content and pressure of H. Above about 850° C., however, the rate of diffusion becomes faster than the rate of reaction between Fe_3C and H, so that the latter becomes the governing factor in decarburization. It is indicated how the Fe-C equilibrium diagram influences the manner of decarburization by H in Fe-C alloys. Below the line GOSK (A_3) a pure ferrite layer forms; between GOSK and 850° C. there is a broader surface layer with intermediate C content, and above the line SK in steels of a composition to the right of the line SE (Acm), a decarburized layer of austenite + Fe_3C, forms at the decarburizing temperature. SE (5a)

High Frequency Heat Treating Equipment for Crankshafts (Hochfrequenz-Kurbelwellenhärteanlage) F. LINNHOFF. *A E G Mitt.*, Mar. 1939, pp. 145-147. Descriptive. Newly developed equipment for selective hardening of crankshafts at Deutsche Edelstahlwerke has the following electrical characteristics: 100 kva., 450-600 volts, 3000 cycles, single phase. The heating coil is a single winding that can easily be attached to object. Time for heating is 4 sec. and for quenching, 8 sec. The relays for heating are adjustable 2-10 sec., for quenching 2-20 sec.; both are accurate to ± 1/20 sec. The apparatus feeds 2 coils that operate alternately. Forty crankshafts with 8 bearings each are treated per hr. This equipment is used for small crankshafts that can be carried by hand. Another one already in operation for large crankshafts, transported on trucks, has 10 coils, 200 kva., 2000 cycles (operating one apparatus with 5 coils, one with 4, and one test apparatus with 1 coil.) JMN (5a)

Flame Hardening and Molybdenum Steels. *Alloy Metals Rev.*, Dec. 1938, pp. 42-44. Abstracted in *Welding Lit. Rev.*, Vol. 1, Feb. 1939, p. 18. Practical. Whatever the steel for flame hardening, the C content should range between 0.35 and 0.50%. One of the steels discussed in this article has the following analysis: 0.42% C, 0.62% Mn, 0.92% Cr and 0.27% Mo, and when flame hardened, has a hardness over 600 Brinell for case depths up to 5/16 in. Steels with the following analysis: 0.45-0.55% C, 1.0-1.25%Mn, 0.40-0.60% Cr, 0.06-0.10% S and 0.10-0.20% Mo have also been successfully flame hardened. Pins of this material have been flame hardened to produce a 1/16 in. case of Brinell and a core of 150,000 lbs./in.^{2} tensile strength without distortion. (5a)

Decomposition of Austenite (Sur un Mode de Décomposition de l'Austénite) ALBERT PORTEVIN & HENRI JOLIVET. *Compt. Rend.*, Vol. 207, Dec. 27, 1938, pp. 1412-1414. Research. Discusses the constituents formed on heating a steel with 0.78% C, 2.85% Ni and 0.75% Cr as follows: Heat 15 min. 900° C., quench in bath held at 650° C. for 30 min., then quench in bath at 480° C. for 30 min., and finally quench in water. Microscopic evidence points to the fact that, at the Ar_1 point, cementite is precipitated, after which supersaturated ferrite is formed. There was no evidence of simultaneous or alternate separation of particles of ferrite and cementite. FHC (5a)

Experiences in the Construction and Operation of Modern Pusher-type Furnaces (Bau-und Betriebserfahrungen an neuzeitlichen Stassöfen) T. STASSINET. *Stahl u. Eisen*, Vol. 59, Jan. 19, 1939, pp. 54-63. Practical. A new pusher-type furnace for a wide strip mill with a capacity of 60 tons/hr. is described. The furnace consists of 3 zones: Preheat, maximum temperature, and homogenizing, each equipped with temperature controllers. A welded steel recuperator preheats the air to 600° C. The extremely low heat consumption of 283 Kg.-cal./kg. of work heated to 1273° C. was attained. Good insulation kept down heat losses. SE (5a)

Quenching Rail Ends with a High-frequency Current. V. VOLOGDIN. *Stal*, Vol. 8, Aug.-Sept. 1938, pp. 47-51. In Russian. Practical. Apparatus is described for quenching the top of rails at the ends for a distance of about 200 mm. A coil operating on 2000 cycle current at 30 volts moves along the rail head at a speed of from 2 to 5 mm./sec., followed by a water spray. Current consumption is 4 kw.-hr. per lineal m. of rail. HWR (5a)

The Specific Heats of Manganese Nitrides. SHUN-ICHI SATOH. *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, Vol. 35, Dec. 1938, pp. 24-31. In English. Original research. The specific heat of the Mn-N system was determined for the first time. The following compounds are known from the literature: Mn_3N_2, Mn_5N_2 and Mn_2N_2. The equilibrium diagram was studied by Schukow, Valensi, Schenk & Kortengräber. Hägg recently found 6 phases by X-rays. The author prepared the above mentioned

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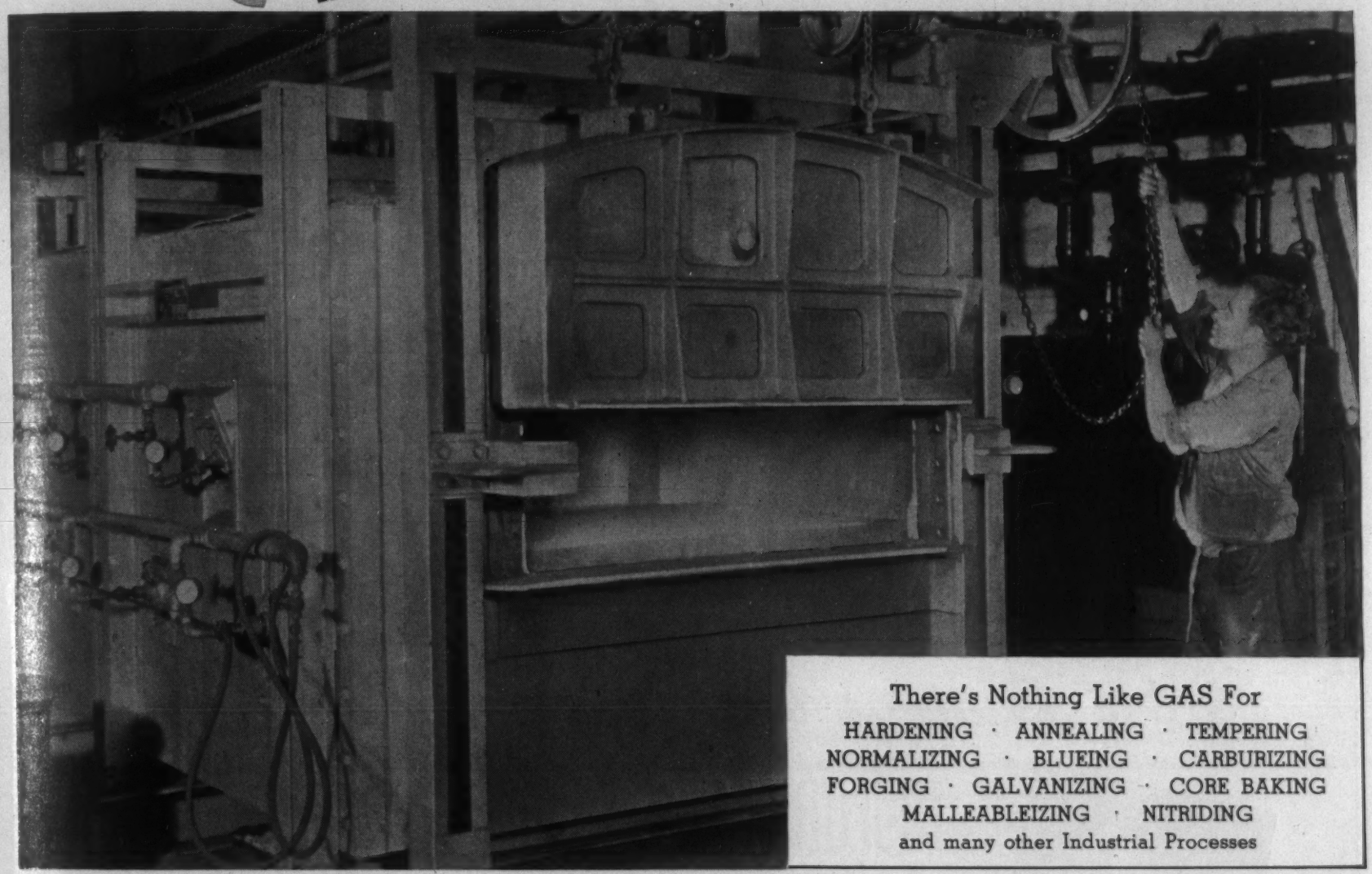

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compounds and established, experimentally, equations of their true specific heats within the temperature limits 0°-500° C. (For previous work, see also *Metals and Alloys,* Vol. 10, Jan. 1939, p. MA 51 L/3. EF (5a)

5b. Non-Ferrous

M. H. MAWHINNEY, SECTION EDITOR

Annealing Characteristics and Solid Solubility Limits of Copper and Copper Alloys Containing Chromium. W. O. ALEXANDER. *J. Inst. Metals,* Vol. 64, 1939, Advance Copy No. 826, 17 pp. Original research. Cr increased the softening temperature and markedly restricted the grain growth of Cu (both tough pitch and O-free), Al bronze, brasses, and Cu-Ni alloys. The influence is so effective that the softening temperature of Cu was increased from 200°-300° C. to 300°-400° C. in the presence of 0.3% Cr, and after annealing at 800° C. the grain size was 0.005 mm. Cu with 0.73% Cr annealed at 900° C. had a grain size of only 0.01 mm. In 7% Al bronze, 0.25% Cr increased the softening temperature from 500° to 700° C. and limited the grain size at 700° C. to 0.01 mm. as compared to 0.1 mm. for a similar material without Cr. In the 70:30 and 80:20 Cu-Ni alloys, up to 0.25% Cr in the former and 0.29% in the latter did not appreciably affect hardness, the softening curves being very similar. Increasing the Cr to 0.45 and 0.54% increased the softening temperatures by about 30° and 50° C., respectively. In applications where Cu alloys are likely to develop large grains because of cold work and subsequent annealing at a high temperature, the addition of Cr will markedly restrict grain growth, so that only normal grain-sizes may be developed. The restrictive action of Cr is attributed to precipitation of Cr from solid solution and mechanical obstruction at the grain boundaries. The solid-solubility limits of Cr in the alloys studied were estimated microscopically and checked by a chemical residue method. JLG (5b)

Some Aspects of the Recrystallization of Cold-worked Aluminum and Aluminum Alloys. L. W. EASTWOOD, R. W. JAMES & R. F. BELL (Aluminum Co. of America) *Metals Tech.,* Vol. 6, Feb. 1939, T.P. 1048, 13 pp. Original research. Three different classes of Al-base alloys were investigated. The first class consisted of a single phase at all temperatures between the solidus and room temperature, the second of a single phase at temperatures near the solidus and 2 phases at lower temperatures, while the third consisted of 2 phases at all temperatures below the solidus. The grain size after annealing or heat treating the cold-worked materials of the first class was unaffected by heating rate. The second class of alloys was unaffected by heating rate within the limits of the experiments provided the soluble material had been completely dissolved during the heating operation, thus leaving a single-phase material. If the temperature was such that the soluble materials remained in part undissolved, this class of alloys was affected by heating rate much as in class III. With materials of class III, a coarser grain was produced when the cold-worked material was slowly heated than when rapidly heated. An investigation of the grain size of high-purity Al showed that if recrystallization of the cold-worked material was just complete—that is, if no coalescence had occurred—the grain size was independent of the time and temperature of the anneal, and was dependent only upon the degree of deformation. In this respect, high-purity Al is similar to α brass. JLG (5b)

The Structural Changes Due to Quenching and Tempering of β Phase Alloys of the Cu-Sb System. A. OSAWA & N. SHIBATA. *Nippon Kinzoku Gakkai-Si,* Vol. 3, Jan. 1939, pp. 5-13. In Japanese. Original research. Structural changes due to heat treatment of β phase alloys, as determined by microscopic, differential dilatometric, and X-ray methods indicated the following: (1) Number of atoms in the unit cell of the β phase is 14, in the atomic ratio of 10 Cu and 4 Sb. (2) By rapid cooling of the β phase, an intermediate phase β′ is formed which decomposes (on tempering), giving first δ phase (expansion), and then θ phase (contraction), and finally decomposes into δ and θ phases at 280°-300° C. (3) This change $\beta' \rightarrow \delta + \theta$ also appears in cast specimens. (4) Alloys of 55.5-63.5% Cu quenched from β field have a face-centered tetragonal lattice with dimensions of a = 5.66-5.89 A.U., c = 5.94-6.08 A.U., c/a = 1.007-1.070, but those of 63.5-68% Cu have a cubic lattice with dimension of a = 5.91-5.928 A.U. or, by tempering, a face-centered tetragonal lattice with a = 5.94-5.97 A.U., c = 5.80-5.88 A.U., c/a = 0.972-0.990. (5) The cubic lattice of the β′ phase interchanges the axes of a and c at about the eutectoid composition (63.5% Cu). (6) By aging of quenched β alloys, the ratio of c/a increases in alloys rich in θ phase, but decreases in alloys rich in δ phase. NS (5b)

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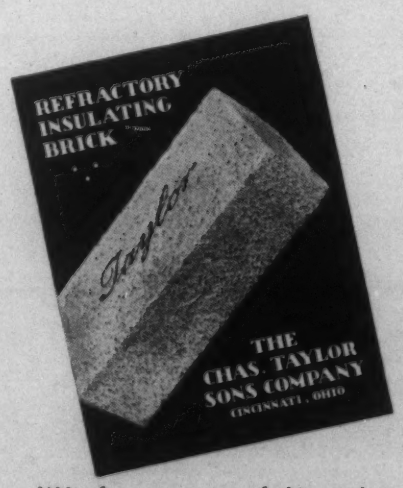

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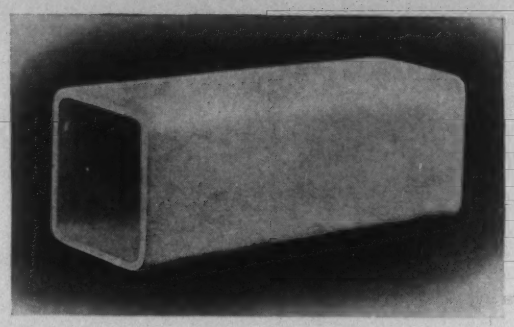

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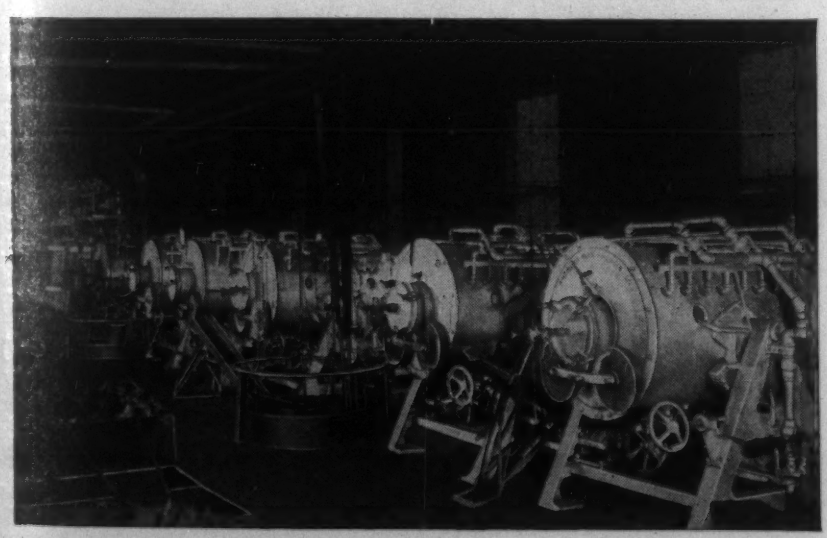

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The Mechanical Properties of Zinc-aluminum Alloys. W. BRONIEWSKI & W. KOWALSKI. *Aluminium & Non-Ferrous Rev.*, Vol. 4, Jan. 1939, pp. 52-55. Original research on Zn-Al and Zn-Al-3% Cu alloys. Alloys were melted in an electric resistance furnace under a slag formed by 3 parts of barium chloride and 1 part of calcium chloride. Zn-rich alloys were rolled at 180°-120° C., then cold drawn; Al-rich alloys were cold-rolled and drawn, with periodical annealing for 30 min. at 400° C. The heat treatments were as follows: Zn-rich alloys were annealed 30 min. at 100° C. cooled in air; hardened at 350° C., 1 hr. Spontaneous tempering at room temperature was completed after 3 weeks. Al-rich alloys were annealed at 400° C. for 30 min., slow-cooled, hardened after 1 hr. at 540° C. Spontaneous tempering gave stable condition after 10 days at room temperature. Mechanical properties were determined on annealed and on heat treated samples. In Zn-base alloys elongation and reduction of area are increased by hardening when the proportion of Al reaches 18%, which corresponds approximately to the limit of the solid solution of the Zn in the combination Al_2Zn_3, which is dissociated on cooling into a eutectoid of very fine structure; the force of fracture (area of tensile test diagram), increases considerably. Pure Zn almost completely loses its ductility in hardening process; this may be due to conversion to allotropical β in stable condition at high temperature. Hardness of Zn-rich alloys is low, reaching only 50 Brinell with 2-7% Al. Tensile strength and elastic limit of Al-base alloys are increased by hardening; elongation is reduced. Reduction of area drops heavily when Zn content exceeds 8%, and is further reduced by hardening. RPS (5b)

Effect of the Silicon Content on the Metallographic and Aging Properties of Al-Cu-Ni-Mg Alloys (Y Alloy) (Effetto del tenore di silicio sulle caratteristiche metallografiche e di maturazione delle leghe Al-Cu-Ni-Mg (Lega Y) C. PANSERI. *Alluminio*, Vol. 6, Nov.-Dec. 1938, pp. 303-313. Original research. Because of its importance in airplane construction, Y alloy has grown in importance and a knowledge of the effect of Si on its properties is of great value. Five alloys, consisting of Y alloy plus 0.14, 0.56, 1.00, 1.56 and 1.92% Si, were used for investigation. The alloys were poured into molds at 720° C. from graphite crucibles and cooled very slowly, so as to allow time for the various constituents to form and segregate. Samples were also tempered at room temperature, as well as at 100°, 200° and 225° C. A number of micro-photographs of etched samples to show the effect on the structure of the various treatments are shown. The maximum amount of Si permissible under the given conditions of heat treatment is determined to be about 0.6%. With proper treatment, Y alloy can be made to reach a Brinell hardness up to 140 (2.5 mm. sphere, 62.5 kg., and 30 sec.) AWC (5b)

Observations on the Aging and Creep Strength of Lead-calcium Alloys (Beobachtungen über die Aushärtung und Dauerstandfestigkeit von Blei-Kalzium-Legierungen) O. HECKLER, W. HOFMANN & H. HANEMANN. *Z. Metallkunde*, Vol. 30, Dec. 1938, pp. 419-422. Experimental. The room temperature aging of a 0.07% Ca alloy quenched from 315° C. was followed by simultaneous measurement of the electrical resistance and hardness. The resistance measurements showed a slight incubation period that was not found in the hardness curve, but, in general, a decrease in resistance paralleled an increase in hardness. Experiments with alloys containing up to 0.19% Ca showed that quenched alloys had a higher initial and final hardness after 10 days than those alloys that were air-cooled. The maximum hardness occurred at 0.13% Ca. Hardness decreased progressively with deformation, owing to recrystallization and recovery. Creep data for pure Pb, Pb-Sb and Pb-Ca alloys at different loads show that, in general, the alloys with the highest hardness show the least creep. GD (5b)

The Relation between the Composition and Aging Characteristics of Cu-Ni-Si Alloys I. T. ISHIKAWA & Y. KONISHI. *Nippon Kinzoku Gakkai-Si*, Vol. 3, Jan. 1939, pp. 31-38. In Japanese. Original research. 55 Cu alloys, containing Ni and Si varying up to 5% of each metal, were cast and rolled into rods, and the effect of composition on the hot or cold working and the relation between composition and capacity for age-hardening by heat treatment were investigated. Alloys with Ni and Si in the approximate ratio of 4:1 have optimum aging capacity, *i.e.* maximum in electrical conductivity and hardness. NS (5b)

The Processes of Aging and Softening in Lead Alloys, especially Hard Lead (Die Vorgänge bei der Aushärtung und Erweichung von Bleilegierungen, besonders von Hartblei) W. HOFMANN & H. HANEMANN. *Z. Metallkunde*, Vol. 30, Dec. 1938, pp. 416-19. Experimental. The aging of Pb alloyed with Sb was studied by measurement of electrical resistance, X-rays, and the microscope, and evidence produced to show that increase of hardness is accompanied by crystallographic precipitation of the Sb. Deformation accelerates precipitation and over-aging. Similar observations were made on Pb-Cd and Pb-Sn alloys. GD (5b)

6 Welding and Cutting

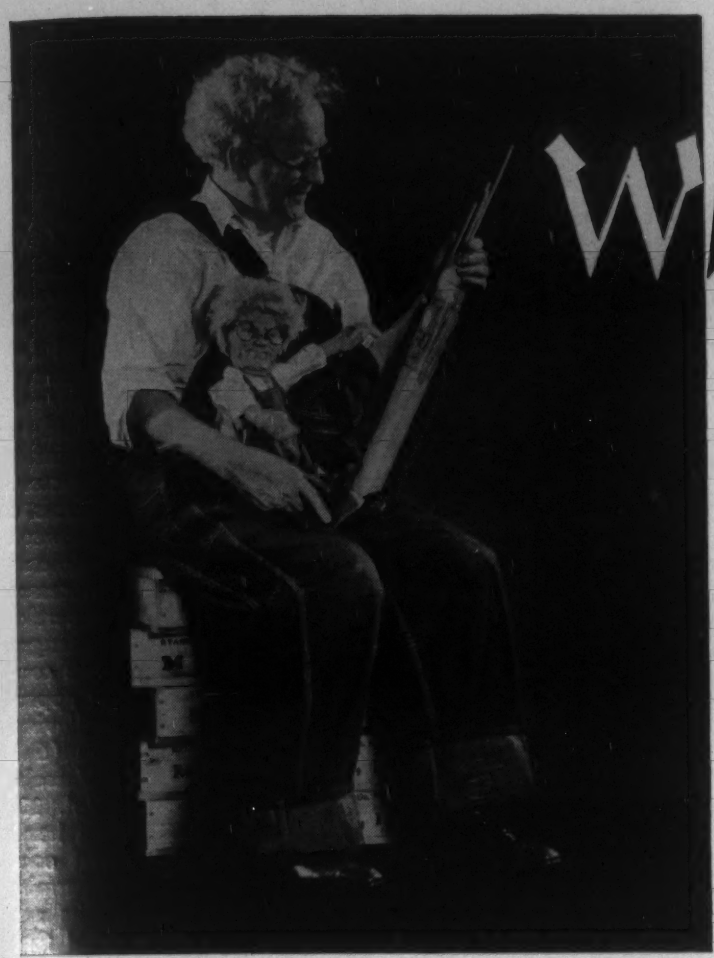
Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

E. V. DAVID, SECTION EDITOR

Data on Spot Welding of 18-8 Stainless Steel to Yellow Brass. F. R. HENSEL, E. I. LARSON & E. F. HOLT (P. R. Mallory & Co., Inc.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, pp. 167-174. Original research. This investigation is admittedly not conclusive, but it does reveal the considerable difficulties that exist in welding 2 dissimilar metals. One point very forcibly brought out is that a choice of suitable electrode material and design of electrode, together with the proper technique, are important. The author points out proper technique for suitable welds in brass to brass and stainless steel to stainless steel. For material 0.040 in. thick the following range of conditions has been determined by actual tests to be adaptable for obtaining satisfactory welds in brass to brass: current timing 4-10 cycles; welding pressure 8,000-14,000 lbs./in.^{2}; kva. input necessary (approximate) 25-50. In the case of stainless steel welded to stainless steel, recommended ranges are: Current timing 2-10 cycles; welding pressure 15,000-40,000 lbs./in.^{2}; and kva. input (approximate) 16-25. In the spot welding of stainless to brass, no conclusive technique has been developed. Fair results were obtained using a current timing of 4 cycles, a pressure of 500 lbs. and kva. input of 17. The recrystallized zone in the stainless steel extends a considerable depth into the brass, producing a definite keying action in the latter. CEJ (6)

Arc Welding in Aircraft. RALPH H. UPSON (Kay Prod. Co.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, pp. 143-146. Review. Sets forth a type of design, embodying arc welding, that is usable in aircraft of the all-metal or stressed-skin type. Present methods of design practically prohibit the general use of arc welding, because of the thin-walled elements involved. The use of heat-treated or high tensile stainless steel, and open or tubular beam supports fabricated by arc welding is suggested. Skin attachment by screws has been found to be reliable when used with steel. The type of construction at present actually used for all-metal aircrafts costs probably 150% more than the arc-welded steel construction with concentrated frame elements. The author counsels against undue haste as in any new design, progressive refinement from practical experience, together with inherent economies and other advantages, can be fully realized only through slow, orderly development. CEJ (6)

Propane as Gas for Welding and Cutting (Propan als Heizgas zum Schweissen und Schneiden) H. BÜRGEL. *Autogene Metallbearbeit.*, Vol. 32, Feb. 15, 1939, pp. 49-56. Systematic tests are described to find whether propane is suitable and economical for welding and cutting. Commercial propane has a specific gravity of 1.52 (air-1). The upper heating value is 23,700, lower 21,800 kg.-cal./m.^{3}; its purity is usually 99.3-99.5%. The tests showed that all non-ferrous metals can be welded satisfactorily, of course with the necessary modification of the usual welding equipment to adapt it for propane. The gas can be used also for steel sheets up to 1 mm.; the welds are as good as with acetylene. For other steel sheets, acetylene is superior, but for small jobs propane is cheaper; the price (in Germany) is 0.70-0.80 RM. for 1 kg. gas in bottles of 1.25, 2.5 and 5 kg., compressed to about 10 atmospheres. Ha (6)



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Low Temperature Brazing. R. N. CHAPIN (Air Reduction Sales Co.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, pp. 137-140. Descriptive review. The term "low temperature brazing alloy" has been used for the last few years as a substitute for the well known term, silver solder. This has been done to lower the sales resistance of prospective customers. This is not hard to understand, for it does seem strange that a precious metal alloy can be used economically in such industries as ornamental brass or bronze work, heating and plumbing, metal furniture fabrication, shipyards, railroads, automotive, etc. The low temperature brazing alloys customarily used have a flow temperature of about 1175°-1532° F. There are 3 well established low temperature brazing alloys on the market today (one is composed of 93% Cu and 7% P, while the second has 80% Cu, 15% Ag and 5% P, both used on Cu and Cu base metals; the third, 50% Ag with a remainder of Cu, Zn and Cd, to be used on Fe, steel, Ni, and other ferrous as well as non-ferrous metals). There are some conditions that must be met before they can be used efficiently or effectively. Perhaps the most important requirement is proper joint design. The alloy should resist shear rather than direct tensile stress, hence a lap, sleeve or some similar type of joint is recommended. In tracing down reports of trouble on brazing operations, the underlying cause very often proves to be careless fluxing. The function of a flux is threefold: (1) It offers a protective coating that tends to prevent oxidation during heating operations; (2) it dissolves any oxides that may form; and (3) it assists in the free flowing of the brazing alloy. CEJ (6)

Automatic Carbon Arc Welding in the Automotive Industry. F. M. MAICHLE (Lincoln Electric Co.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, pp. 147-151. General discussion. Automatic shielded arc welding has become the accepted method for fabricating various automotive parts. The high quality and low cost of welding by the shielded C arc process are the result of the development of the electronic tornado system of controlling the C arc in automatic welding. Focusing and localizing the arc stream so that all the heat is concentrated in a very small area directly beneath the arc is of tremendous importance. This controlling of the arc is accomplished by superimposing a strong magnetic field on the arc stream. The magnetic field checks wandering tendencies of the arc and gives the electrons of the arc stream a rapidly gyrating motion that puddles the molten metal and refines it. It is this swirling motion of the electrons that gives the electronic tornado its name. To eliminate the action of the air, a controlled atmosphere or shield is formed around the arc. High welding speeds are possible, for example, 300 feet/hr. of 14 gage straight butt weld, or 130 feet of a corner butt joint/hr. are possible. Mufflers for one of the popular priced automobiles are arc welding by the electronic tornado process at a rate of 250 completed units/hr. Engineers estimate that the cost of producing a popular-low-priced car today without welding would be about $3,000. CEJ (6)

Oxy-acetylene Developments. *Welding Engr.*, Vol. 24, Feb. 1939, pp. 26-29. Review. New oxy-acetylene cutting machines and new cutting procedures, such as stack-cutting, are revolutionizing machine design requirements and manufacturing operations. New multi-flame tips and welding rods are speeding the welding of pipelines 25-75%. New welding techniques are greatly extending the usefulness of the new corrosion resistant steels that permit light weight construction. New developments in processes, such as flame-hardening, flame-softening and deseaming, are introducing new conceptions in metal-working. CEJ (6)

6a. Ferrous

The Oxy-acetylene welding of Wrought Iron. *Ind. & Welding*, Vol. 12, Mar. 1939, pp. 49-50. Practical. The procedure for welding wrought iron by the manual oxy-acetylene process is practically the same as that followed in welding soft steel of the same thickness. However, one important thing to be remembered is that the iron silicate or slag included in the metal melts at a temperature that is below the fusion point of the iron base metal. It is advisable to use a welding rod that has a yield point near that of high quality wrought iron (27,000-30,000 lbs./in.^{2}). A neutral flame has been found to give the best results for oxy-acetylene welding wrought iron. A step-by-step method of depositing beads produced the best results. A table is given, outlining the essential details of the procedure for manual oxy-acetylene welding. CEJ (6a)

Tensile Properties and Weldability of Thin Sheet of High Strength Structural Steel (Festigkeitseigenschaften und Schweissbarkeit dünner Bleche aus hochfesten Baustählen) H. CORNELIUS & F. BOLLENRATH. *Arch. Eisenhüttenw.*, Vol. 12, Jan. 1939, pp. 335-339. Practical. A series of 7 low alloy high strength steels containing C from 0.25 to 0.32%, Si from 0.3 to 1.35%, Mn from 0.6 to 1.17%, Cr from 0 to 1.13%, and Mo from 0 to 0.30% were made in an 8 kg. induction furnace, rolled into 0.8 to 1.2 mm. sheet, gas welded and tested; tensile and hardness tests at the welds were made. The requirements were a tensile strength of 100,000 lbs./in.^{2}, without undue brittleness or hardening at the welds. These requirements were obtained in 2 of the steels, one with 0.3% C, 1.4% Si, 1.2% Mn and 0.25% Mo, and the other with 0.3% C, 0.6% Si, 0.9% Mn, 0.6% Cr and 0.2% Mo. The data obtained from these laboratory melts were very useful. SE (6a)

The Structure of Annealed Welds in Boiler Plate (Das Gefüge geglühter Kesselblechschweissungen) H. BUSCH. *Mitt. Forsch. Anstalt. Gutehoffnungshütte Oberhausen*, Vol. 7, Jan. 1939, pp. 1-14. Original research. The required "normalizing" anneal (at 700°-900° C.) above the upper transformation point of the material has many practical inconveniences. Simple "stress-relief" annealing (at 600-650° C.) was investigated as to whether it would be sufficient and in what manner the structure of the weld was influenced. Normalizing causes a sharp separation in the structure between parent material and weld, while stress-relief produces a gradual transition without noticeable structural differences between plate and weld. The mechanical properties of both heat-treatments are equivalent. The different effects of both annealing processes are shown in micrographs, and tests of mechanical properties described. Stress relieving also produces certain structural changes that are due to precipitation of forcibly dissolved constituents containing C, N and O below the pearlite temperature. The appreciable improvement of toughness connected with stress-relieving may be due to this precipitation. 14 references. Ha (6a)

New Developments in the Welding of Pressure Vessels. G. K. HULL (Am. Locomotive Co.) *Ind. & Welding*, Vol. 12, Feb. 1939, pp. 16-19, 36-37. Practical. The change from hand welding to automatic welding has reduced repairs to about one-third in X-rayed welds. The single pass type of welding permits high rates of speeds in welding, and most excellent results are obtained. With the use of automatic welding, it was found that steels purchased to the same A.S.T.M. specifications and passing them satisfactorily did not weld equally. Various steel companies have recognized this and have moved to improve conditions. The use of rotating devices and positioning machines has made very effective savings in the cost of production and has improved the quality and appearance of welds. In welding alloy plates, preheating before welding is not necessary in steels containing less than 0.15% C, or under 1½ in. thick, although it is safer to do a little preheating in all cases, particularly where Cr is the alloy. The use of clad or lined material increases the fabrication care necessary. Stress relieving has now been generally adopted. X-raying has brought about a very definite improvement in the control over welding. CEJ (6a)

The Influence of Carbon and Manganese on the Weldability of Steel (Der Einfluss von Kohlenstoff und Mangan auf die Schweissbarkeit von Stahl) H. CORNELIUS. *Z. Ver. deut. Ing.*, Vol. 82, Oct. 8, 1938, pp. 1200-1203. The survey of literature on this subject made by W. Spraragen & G. E. Claussen (See *Metals and Alloys*, Vol. 9, Mar. 1938, p. MA 166 R/3) was enlarged to the present day and general conclusions are discussed. The ratio of % Mn/%C seems to have no effect on the weldability, and no special procedures for welding are necessary in ordinary Mn steels if C does not exceed 0.25%. With Mn contents from 1% and higher, however, a tendency to martensite formation occurs with increasing C content, which can be counteracted by preheating. Flame-cutting can easily be done up to Mn contents of 1.3%, and Mn-V steels with 0.17% C, 1.35% Mn and 0.1% V could be cut in this manner up to 100 mm. wall thickness. 66 references. Ha (6a)

Effect of Normalizing on the Mechanical Properties and Weldability of Structural Steel St52 (Einfluss des Normalglühens auf Festigkeitseigenschaften und Schweissverhalten von Baustahl St52) R. WASMUHT. *Stahl u. Eisen*, Vol. 59, Feb. 23, 1939, pp. 209-212. Research. 20-50 mm. thick plates of 0.18% C, 0.4% Si, 1.0% Mn, 0.3% Cr and 0.5% Cu steel were welded and tested. Normalizing such fine-grained steel before welding improved the bend properties of the weld, even when the specimens were not preheated before welding, but only stress-relieved after welding. Such normalizing avoided brittle fracture at the welds. The improvement resulting from normalizing became especially noticeable in plate over 30 mm. thick, so that such plate could be welded with complete safety. SE (6a)

Welding. The Speedy Fabrication Method. J. C. HOLMBERG (Struthers-Wells Titusville Co.) *Ind. & Welding*, Vol. 12, Mar. 1939, pp. 52-54. Practical. 65,000 lbs. of material, both stainless and structural, fabricated in a period of about one month, bear witness to the efficiency of the welding process. A stainless steel rotary converter, a stainless steel cooler complete with a structural steel support and all other auxiliaries were built. The kiln body proper was composed of a stainless alloy (0.20% max. C, 22-26% Cr and 11-13% Ni) 7/16 in. thick; 45 ft. long and 7½ ft. in diameter. The cooler section was built of an alloy with a composition 0.08-0.20% C, 17-19% Cr, 7-9% Ni, 3/16 in. thick, 40 ft. long and 4½ ft. in diameter. CEJ (6a)

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Welding Chromium and Chromium-nickel Corrosion and Heat Resisting Steels, A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN (Welding Res. Comm.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, Suppl. pp. 65-107. Unusually comprehensive review. In view of the low thermal conductivity, high thermal expansion and the necessity for maintaining the C and the Cr content at a low and a high level, respectively, the basic rules underlying all welding procedures for 18.8 are: (1) Do not use excessive heat, and (2) use a welding process that does not carburize or oxidize the 18-8. The metallic arc is generally used in welding 18-8 plates thicker than 1/16 in.; coated electrodes having a diameter approximating the thickness of the members to be joined with a maximum of 3/16 in. are ordinarily used. The core rod should not contain over 0.07% C. Current is 10 to 15% less than for mild steel. Tensile strengths of all-weld-metal deposits vary from 70,000 to 85,000 lbs./in.^{2} The chief applications of the 18-8 electrode, aside from welding 18-8, are in welding plain C and low-alloy steels, as well as alloy steels that are difficult to weld. Intergranular corrosion occasioned by carbide precipitation is bound to occur in the heat-affected zone of welded 18-8 in severely corrosive reagents, unless the joint is heat treated or unless the 18-8 contains an alloying element to prevent intergranular corrosion, or unless the C is exceedinly low. The principles of spot welding 18-8 are based on its low thermal and electrical conductivity. Less power is required than in mild steel and this is accomplished by faster timing. Owing to greater stiffness, more pressure is needed—50-100% greater than for mild steel; pressures as high as 50,000 lbs./in.^{2} give best results with polished 18-8, 0.028 in. thick. In welding 18-8 sheet thinner than 0.05 in., oxy-acetylene welding is often used. An oxy-acetylene all-weld-metal made with an 18-8 rod had a tensile strength of 79,500 lbs./in.^{2} Surfacing with 18-8 rods has had its chief application in repair of cast iron turbine runners. Successful resistance welding of 18-8 to plain C steel is entirely feasible. The joints almost invariably break under load in the plain C steel at a section removed from the weld. In arc welding 18-8 to plain C steel, there is a thin, hard, martensitic band on the steel side caused by diffusion of Cr and Ni. Preheating is sometimes advisable. Cb is added to 18-8 to prevent intergranular corrosion. Mo (2-5%) is added to 18-8 to increase the resistance to corrosion, particularly by non-oxidizing reagents such as HCl and H_2SO_4. From the standpoint of ease of welding, Mo up to 5% has no unfavorable effect. An alloy of 18-8 containing Ti is said to be "stabilized"; with small amounts, presumably 1% Ti or less, the weld metal is completely austenitic. It is generally agreed that W (1%) additions to 18-8 retard but do not prevent intergranular corrosion after welding. The procedure for oxyacetylene and metallic arc welding of steels of the 25-12 type (0.20% C max.) is the same as for 18-8. The filler rod has the same composition as the base metal. Spot welding of 25-12 and higher alloy steels is particularly easy on account of their low thermal and electric conductivity and low melting point. Although 25-20 is primarily a heat resisting steel, it is used widely as a filler rod for welding mild steel. Welds made with 25-20 electrodes in plain C steel have high ductility up to 0.56% C, beyond which the ductility decreases. Oxy-acetylene welding with a 25-20 rod can be applied to plates up to 0.39 in. thick. 25-20 is less subject to intergranular corrosion than 18-8; it should be preheated for welding and need only be stress-relieved after welding, unless the requirements are severe. Satisfactory welds can be made in 20 Cr-20 Ni, 15 Cr-9 Ni, 25 Ni-15 Cr and 35 Ni-15 Cr under suitable conditions. 18 Cr-8 Mn steel (0.12% C max.) can be satisfactorily arc or oxy-acetylene welded. Stainless irons, or ferritic steels as they are sometimes called, may be grouped in 3 classes: (1) 13 Cr, 0.12 C max., (2) 18 Cr, 0.12 C max., and (3) 25 Cr, 0.3 C max. Class 1 is capable of being heat treated to 350-400 Brinell, the grain structure being refined in this way. The other 2 classes of stainless irons are completely or nearly ferritic at all temperatures. They are subject to coarse grain growth on being overheated, a condition that cannot be removed by heat treatment and which renders the Fe brittle at room temperature, although the hardness is always below 200 Brinell unless the irons have been cold worked. The main difficulty in welding martensitic (Class 1) stainless iron is air hardening and embrittlement of the heat-affected zone, together with some loss of corrosion resistance. The remedy is annealing or quenching and tempering after welding. In class 2 or 3 irons, on the other hand, the heat affected zone is brittle at room temperature or below, and is tough above 200° C.; the brittleness cannot be overcome by heat treatment. Martensitic stainless steels generally contain 11-18% Cr with 0.15-1.0% C. Their outstanding application is in cutlery. They are not recommended for welding any more than are plain C steels containing over 0.35% C. Annealing and slow cooling are usually essential. On account of the good corrosion resistance and color match of silver solder, it is used extensively for joining stainless steels. Although the manipulation of wire and torch is the same for stainless steels as for mild steel, the stainless steel surface requires a different flux with sometimes a different solder. Because of the tendency to intergranular penetration and consequent loss of ductility, brazing or bronze welding is not good practice for Cr and Cr-Ni corrosion resisting steels. A tabular summary giving welding procedure, precautions, heat treatment, mechanical properties, electric resistance, corrosion resistance, thermal expansion and thermal conductivity is included. 302 references. CEJ (6a)

High Tensile Steel in Building Construction. G. SCHAPER. *Bautechnik*, Vol. 16, 1938, pp. 649-655. (In German.) Abstracted in *Welding Lit. Rev.*, Vol. 1, Feb. 1939, pp. 20-21. Descriptive. Briefly explains the advantages of high tensile steels and especially the German high tensile steel St52. St52 was first successfully welded in heavy rolling stock and in the shipyards where a "quench bend" acceptance test has been evolved. The saving in cost made possible by this type of construction in buildings has enabled Germany to secure valuable contracts abroad. Some time after the welding of St52 had been adopted by the German State Railways, cracks appeared in the Zoo station single track railway bridge after it had seen 6 months service. These started at the fillet welded "ribbed" profile and ran up into the web. Shortly afterwards, cracks appeared during the erection of the Rudersdorf Autobahn bridge after a drop in the atmospheric temperature of 10° C. These cracks occurred through the bottom flange of the girder and ran right up through the web. In both cases, the cracks showed no signs of deformation, possibly because of a state of tri-axial stress. All fillet welds in the "ribbed" profiles of the Rudersdorf bridge had been examined by X-rays. Research subsequent to the failure showed that the alloying content of the steel was too high, which caused excessive hardening in the thick sections, leading to cracking under residual stress. The Germany State Railways, therefore, specified the following limits of alloy contents for St52: 0.20% C, 0.50% Si, 1.2% Mn, 0.55% Cu, 0.06% P, 0.06% S, 0.10% S and P together, with further additions of either 0.30% Mn, or 0.40% Cr or 0.20% Mo. The weldability of various types of St52 has been judged from the results of bend tests, and although the results of this research are not quoted, the following conclusions are mentioned: (1) Fillet welds on the edges of plates, as used in the welding of stiffeners may be safely employed even in heavy plates in St52. (2) Preheating gives a better distribution of internal stress. (3) Thin plates are more readily weldable than thicker plates. (4) Normalized steel St52 is more readily weldable than St52 that has not been normalized. (5) Split Gray beams of T sections used as flanges can be reinforced by welding cover plates without causing unfavorable distribution of stress. Approximately one million tons of St52 have been rolled in Germany, 200,000 tons of which have been welded. Isolated cases of failure have led to a temporary slackening of progress in the welding of this steel, but ultimate solution of all the difficulties encountered is expected. (6a)

Impurities in the Molten Metal of Welds (Les Impuretés dans le Metal Fondu des Soudures) A. LEROY. *Rev. Soudure Autogène*, Vol. 31, Feb. 1939, p. 615. Case history. Some coated welding electrodes contain excessive amounts of impurities, especially P and S. The manufacturer claimed that the coating of the electrode purifies the metal when molten, reducing the percentage of impurities below the range where they are harmful. Experiments showed, however, that the content of P in the weld increased in most cases; in a few instances it reached a value several times that of the original amount. The additional P is introduced in the metal from the coating of the welding rod containing ferro-alloys, especially ferro-manganese. The P content attains the highest values when the Mn content, as introduced in the molten metal by means of the core, increases simultaneously. The content of ferro-alloys cannot be reduced because of the important and useful effect of Mn in deoxidizing and increasing the strength. The increase in impurities seems to be objectionable, however, especially for quality welds. The chemical and mechanical properties are weakened. RPS (6a)

Welding of High Temperature High Pressure Vessel. TETSUO SAITO. *Trans. Soc. Mech. Eng., Japan*, Vol. 4, Aug. 1938, pp. 269-273. In Japanese. English abstract, pp. S44-S46. Original research plus review. The riveted boiler has been replaced by the forged drum for extreme pressures. The latter has considerable disadvantages, and the trend towards electrically welded high pressure vessels is apparent in Japan. If the plate thickness exceeds 16 mm., the U- or V-shape weld should be applied. If the diameter of the vessels is not very large, the U shape is recommended. Preheating to 50-60° C. of the section for the first layer is supposed to avoid blow holes and cracks. Diagrams are presented showing the relation between stress and creep rate of 0.25% C steel boiler plate and of 0.16% C weld metal at various temperatures. At 350° C., the strength of both is about equal. A further diagram shows the effect of peening on tensile strength, elongation, yield point and impact strength for the annealing range of 650-920° C. Among the results of peening are increase in specific gravity and corrosion resistance. EF (6a)

Physical Properties of the Iron-nickel Alloys Formed in the Welding of Nickel-clad Steel. W. G. THEISINGER (Lukens Steel Co.) & F. G. FLOCKE (Internatl. Nickel Co.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, Suppl. pp. 108-112. Research. Tests are reported showing the strength of the bond between the cladding and the base plate, and the effect of proper and improper joint set-up for butt joints. A bar of Ni was welded with a Ni electrode to the Ni cladding and, in like manner, a steel bar was joined to the steel side of the plate of the 1-in. thick, 20% Ni-clad steel sample using a steel electrode. Tests on several specimens so prepared disclosed strengths of the 0.505 in. diameter specimens between 50,000 and 52,000 lbs./in.^{2}, with fractures in the steel weld. Confirmation of this bond strength was obtained by a large user of Ni-clad steel, demonstrating that the strength of the bond between the Ni cladding and the steel plate is greater than the strength of the steel itself. In the welding of Ni-clad, the desired result is reached when the bottom of the first steel pass just contacts the Ni-steel interface. If the steel bead is incompletely penetrated, an excessively deep groove must of necessity be chipped, with the result that an excess of Fe is picked up during the deposition of the Ni weld. If too much penetration is obtained, so that the steel weld metal actually penetrates beyond the outer Ni surface, then some difficulty may be experienced, because the Fe-Ni alloy thus formed may be as hard as the chipping tool. That an approach to the optimum is commercially practical is shown by the fact that satisfactory fabrication is possible, as well as by the service record for the many tons of equipment in use. Since the deposition of the first steel pass is so significant the variables, such as bevel, heat, joint offset, cladding and plate thickness were studied and their effects determined by a hardness survey of the cross section of the weld. Two types of single-vee bevel were used, varying only in the straight portion or lip at the base of the vee. In one case the plate was beveled not quite to a feather edge, but with only the thickness of the cladding left unbeveled. In the second case the lip included the cladding thickness plus 1/16 in. of the steel. A total of 90° included angle was used in all cases. A good quality steel electrode 5/32 in. diameter was used in 2 welding currents, namely, 135 and 185 amp. Where the joints were flush, neither current penetrated beyond the Ni-steel interface. With proper joint design, good joints will result if a good welding technique is used. Although this is based on work on 3/8 in. clad plate, the fundamental principle of providing a lip of steel in addition to the cladding will also hold for thicker plate. CEJ (6a)

Carburized Welds. E. J. WELLAUER (Falk Corp.) & G. C. DOEHLER (Hevi Duty Electric Co.) *Welding J., N. Y.*, Vol. 18, Mar. 1939, pp. 163-166. Original research. The test welds were in forged and annealed S. A. E. 2315 steel, widely used as a carburizing steel for miscellaneous machine elements. Two specimens were welded for each of 4 analyses of rods, namely, a 2½% Ni rod, S. A. E. 2315 rod, a straight C rod, and a C-Mo rod. One specimen was peened with an air hammer after each pass; the other specimen was not peened. Coated rods were used 5/32 in. in diameter, with a current of 140 amperes at 22 volts d.c. The welds were made and then normalized at 1650° F., after which the weld bead was machined level with the parent metal. The specimens were carburized for 10 hrs. at 1700° F. using a gaseous carburizing medium. The sections to be hardened were then oil-quenched from 1425° F. and drawn at 350° F. The following observations were made: The C-Mo and 2½% Ni rods produced the more desirable welds with the procedures used in this test. With the exception of the S. A. E. 2315 rod, the C penetration into the weld metal was less than the parent metal. The alloy rods produce a case that matches the parent metal case hardness for most practical purposes. Peening has no marked effect in this investigation. A weld rod should be of the composition that will minimize the introduction of dissolved gases and should be selected as to produce the least variation in case and core structure and hardness between the weld and parent metal. CEJ (6a)

6b. Non-Ferrous

Riveting with Age-hardening Light Alloys. J. W. SMITH. *Light Metals*, Vol. 2, Mar. 1939, pp. 96-97. Review. The use of duralumin rivets has always been accompanied by the necessity of either driving them almost immediately after solution quenching, or of refrigerating them to inhibit age hardening until ready for use. Recently K. Matthaes has shown that, by increasing the Mg content and by lowering the Cu content, an alloy may be obtained that age hardens much more slowly than ordinary duralumin, but whose ultimate physical properties are substantially the same as duraluminum. Appreciable age-hardening of an alloy of 2.08 Cu, 2.10 Mg, 0.79 Si, 0.55 Mn and 0.15% Fe sets in only

Dotted line marks position of pipe before washout.

AGAIN...Nature proves that WELDED STEEL *CAN TAKE IT*

SETTING. Santa Maria Reservoir on North Clear Creek near Creede, Colorado. Welded steel 84-inch pipe line 8100 feet long diverts water from creek into canal.

EVENTS. Outlet became jammed with ice. Backup caused overflow of water from concrete outlet structure, washing out a hole 24 feet deep. Span of pipe 60 feet long, full of water and ice, hung in mid-air until concrete structure was undermined. Pipe dropped, pivoted at a welded girth seam where it crumpled. Diameter of entire span of pipe was flattened down to about 72 inches.

RESULT. Not a single break occurred in pipe or welds. This confined the flow to the outlet and reduced washout damage. Flattened pipe was straightened out. Crumpled section was replaced with new pipe, welded in.

MORAL. For maximum strength, ductility, tightness, engineering freedom and cost reduction, *specify welded construction with "Fleetweld" Electrodes.*

For further details consult the nearest Lincoln office. THE LINCOLN ELECTRIC COMPANY, Dept. LL-608, Cleveland, Ohio.

Point of bend occurred at a girth weld seam.

Photo courtesy of The Thompson Manufacturing Company, Denver, Colorado, who built this pipe line with Lincoln "Shield-Arc" Welders and "Fleetweld" Electrodes.

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after 9 hrs. at 20° C., or 34 min. at 35° C. [These figures have been correctly transcribed.—Editors.] The shear strength of hammered rivets is 36,000 lbs./in.^{2} after 20 days at 20° C. and 40,500 lbs./in.^{2} after 20 days at 50° C. The corrosion resistance in alternate immersion in artificial sea water is greater than ordinary duralumin. In this connection, it would appear from the recently published work of D. A. Petrov, *(Metals and Alloys,* Vol. 9, Sept. 1938, p. MA 566 L/1) that the constituent responsible for the hardening of the riveting alloy is $Al_5Cu_2Mg_2$; this compound precipitates more slowly than $CuAl_2$ from solid solution. Si apparently does not enter into the hardening process, as Petrov showed that Mg_2Si does not precipitate at low temperatures. However, the Si seems to increase the softness of the alloy in the quenched state, and hence it may aid in causing the other constituents to dissolve more readily in solid solution. Also, Petrov found that Fe inhibits the ordinary temperature age-hardening of duralumin, while the addition of Mg restores age hardening. With the more common use of high purity Al, more attention can properly be paid to the effects of small additions of alloying constituents. The consequent improvement in composition control should reflect an accompanying improvement in physical properties. AUS (6b)

Welding of Zinc (Schweissen von Zink) PETERSHAGEN. *Autogene Metallbearbeit.,* Vol. 32, Mar. 1, 1939, pp. 72-75. Practical. Welding of Zn is recommended instead of the much more widely used soldering, as (from the German standpoint) soldering requires Sn which has to be imported. Welding is best done with the oxy-acetylene torch, but the temperature must be carefully observed because of the rapid change, with temperature, of tensile strength and elongation of Zn.

Temp. ° C	Tensile strength, lbs. per in.^{2}	Elongation %
20	23,000	30
100	18,500	38 (best working temperature)
200	8,500	20
300	5,500	10
350	3,000	3

Melting point is 419° and boiling point 907° C. The flame should be adjusted to neutral, but a slight excess of acetylene is permissible rather than an excess of O as used for welding Zn-containing Cu alloys (brasses). Correct preparation and shape of the seam is illustrated, and several examples are given. Ha (6b)

Spot Welding in Aircraft Construction. W. BORSTEL. *Junkers Nachrichten,* July, 1938, pp. 177-183 (In German). Abstracted in *Welding Lit. Rev.,* Vol. 1, Feb. 1939, p. 28. Descriptive. The advantages of spot welding compared with riveting in metal aircraft construction are a reduction in cost of production and weight, and the production of a smoother surface. Experience gained during introduction of spot welding in current production at the Junkers Works is discussed. Pure Al, Al-Mg alloys, Al-Mg-Si alloys and Mg alloys, *i.e.* all light metals except Al-Cu-Mg alloys, can be spot welded satisfactorily. The maximum thickness of sheet that can be welded, which is limited by the length of reach of the welding machine arm and the output of the transformer, is about 1/8 in. at present. Before welding, rolling mill scale and oxide films must be removed from both sides of the sheets, since these lower the quality of the weld and foul the electrodes. Cleaning is effected by brushing or pickling, according to the shapes to be handled and the number of spots to be welded. In addition to proper surface conditions of the sheets, the correct electrode pressure, welding time and current strength are important for neat and sound welds. Mechanical pressure depends on the tensile strength of the material to be welded and should be about 200 lbs. for a tensile strength of 20,000 lbs./in.^{2}, about 370 lbs. for a tensile strength of 40,000 lbs./in.^{2}, and about 480 lbs. for a tensile strength of 50,000 lbs./in.^{2} Very short welding times must be used when spot welding light alloys. The best welding time for Duralumin sheet lies between 4 and 8 cycles with a current of 50 cycles per sec., equivalent to a time between 0.08 and 0.16 sec. Current strength depends on the sheet thickness, the surface condition, the electrode pressure, and, to some extent, also, the welding time. The best current strength to be used is comparatively easy to ascertain if all these factors are kept constant. The use of spot welding involves basic re-design of components, mainly because of the need to take very carefully into account the shape of the arm and electrode holders on the welding machine. Therefore, the author urges the closest cooperation between research, design and production staff. (6b)

These Are the Latest Methods of Aluminum Welding. J. H. ANSTRUTHER. *Sheet Metal Ind.,* Vol. 13, Feb. 1939, pp. 267-270. Review. Gas welding is the most popular, using either oxy-acetylene or oxy-hydrogen flames. Welding rod is usually the same as parent metal, except that 5% Si alloy is used for some of the complex alloys, and small additions of Ti have been found to refine the weld grain and improve the strength of the weld. Resistance welding is important in aircraft construction. Pure Al sheet of 22-10 gage, and Al alloy sheet up to 6 gage can be spot welded; while upper limits for seam welding are 16 gage for pure Al, and 12 gage for alloys. Arc welding is being used increasingly for 16 gage to 1/2 in. thick sheets, with coated electrodes; however, it is best adapted to standardized jobs. Welds are tested by X-ray, or a test coupon is examined in the laboratory. JZB (6b)

The Weldability of Pure Lead During Extrusion at Different Temperatures (Untersuchung der Verschweissbarkeit von Reinblei durch Verpressung bei verschiedenen Temperaturen) B. MEYER & H. HANEMANN. *Z. Metallkunde,* Vol. 30, Dec. 1938, pp. 422-424. Experimental. Composite billets were prepared by piling discs of 99.99% Pb together. These were extruded into rods that were examined microscopically and by tensile fracture. The fracture was of a compound nature, indicating incomplete welding at extrusion temperatures between 20° and 300° C., and the microscope showed an oxide layer at the weld. When the discs were tinned by hot dipping before being piled into the billet, better welds were obtained, but they were never completely satisfactory. GD (6b)

Electric-arc Welding of Aluminum (Ueber die Lichtbogenschweissung des Aluminiums) C. AUCHTER. *Aluminium,* Vol. 21, Feb. 1939, pp. 139-152. Practical. The process of welding Al and its alloys with the electric arc is explained in detail in 3 consecutive articles. Fluxes to protect the molten surface against oxidation must melt below 658° C., the melting point of Al, and their specific gravity must be less than 2.38, so that they can float on the fused part. Data for preparing, treating and selection of welding electrodes, physical and mechanical properties of the weld and zones nearby, and heat-treatment of welds are given in many tables. Numerous examples illustrate application of welding. Ha (6b)

Riveting of Aluminum (Das Nieten) E. VON BURG. *Aluminium.* Vol. 21, Feb. 1939, pp. 131-134. Practical. To avoid corrosive action, rivet and material should be of the same composition and, if possible, in the same heat treated condition. Al on Fe should be riveted with Fe or steel rivets. The rivets are precipitation-hardened in a salt or air bath and quenched in cold water; Al-Cu-Mg should be heated to 500 ± 5° C. and Al-Mg-Si to 505 ± 5° C.; the temperatures must be strictly observed. Al-Cu-Mg rivets must be used immediately, for after 1-2 hrs. age-hardening has become excessive; otherwise they should be stored in ice or at 0° C. Al-Mg-Si rivets are sometimes preferable as they can be used at any time even in the hardened condition. Mechanical and physical data are given for construction purposes. Ha (6b)

7 Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

Some Notes on Routine Corrosion Tests for Tinplate. W. E. HOARE. *Sheet Metal Ind.*, Vol. 13, Feb. 1939, pp. 227-228; Mar. 1939, pp. 374-376. Comprehensive review. *Porosity tests* simply demonstrate the continuity of the coating and do not show potential pores (unless sheet was deformed before testing) or corrosion characteristics of the steel base. There is a straight line relationship between the porosity and coating thickness of hot-dipped tinplate: $\log_{10} P \pm 0.505 = 3.653 - 2.785 \log_{10} Y$, where P = number of pores per 100 sq. cm., and Y = thickness of Sn in lbs./basis box. The second term represents the limits within which 95% of the results lie. However, the test is not extremely accurate and should be used merely as a supplement to the determination of the thickness of the Sn coating. *Acid test:* Loss in weight is determined after 24-hr. exposure to a solution of N/200 HCl + 15 p.p.m. SO_2 at 32° C. This medium attacks the exposed Fe in preference to Sn. *Electrolytic sulphidizing:* The Sn plate is made anode with a C cathode in a solution of NaHS, using 1-2 amp./dm.^{2} and 5-10 volts. After 10 min. normal and potential cores as well as unevenness in coating are visible. The test may be made quantitative by continuing it longer and determining the sulphide. *Hydrogen evolution:* Determines the time for a standard specimen to evolve 5 cc. H_2 in N. HCl. This value has been correlated with service results as the time in months for 50% of size 2½ plain tin cans to H swell when stored at 100° F. Correlation of all tests with service results shows definitely that the porosity is related to the thickness of the Sn coating, which in turn is related to service life. JZB (7)

7a. Electrolytic Methods

Factors to Be Considered in Cleaning Before Bright Nickel Plating. E. C. RINKER (Oakite Prod. Co.) *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 26, Jan. 1939, pp. 33-36. Practical. Contamination of the alkaline cleaner with 0.0005 oz. of CrO_3 per gal. will prevent adhesion of Ni to brass, and 0.07 oz. of CrO_3 per gal. of plating bath will ruin the Ni deposits. Unsaponifiable oil left from machining operations is best removed by an emulsifying solvent, which, by mixing with the oil, causes it to emulsify in water. Finger stains on buffed Cu or brass cannot be removed by cleaning, and will be visible even after Ni plating. This can be prevented only by handling with cotton gloves. When buffed articles are given the usual degreasing or alkaline cleaning procedures, a smut may still remain on the surface. This can be removed only by mechanical scrubbing in an alkaline solution. Other difficulties in cleaning are caused by too much soap in the cleaner, which forms a fatty acid film when the object is acid dipped. Soldered work requires a special cleaning procedure, because alkaline cleaners attack solder. In rosin cleaners, thorough solution of the rosin is important, as incompletely saponified rosin may adhere to metal surfaces. AB (7a)

Depositing Uniform Thickness of Metal for Plating to Specifications. JOSEPH HAAS. *Metal Ind., N. Y.*, Vol. 36, Oct. 1938, pp. 478-480; Vol. 37, Jan. 1939, pp. 24-26. Plating to specifications is complicated by variation in thicknesses of deposits. The fundamentals of current distribution are discussed. Increasing current density decreases the size of crystals, giving hard and close-grained deposits; increases rate of deposition; increases cathode polarization, thus improving throwing power; and decreases cathode efficiency. Cathode agitation or motion replenishes cathode film with metal ions and permits use of higher current density, but stirs up sediment and decreases throwing power. Continuous filtration keeps solution clear of sediment and metallic particles, maintains uniform density in the solution, and does not reduce throwing power to the same degree as cathode agitation. Increasing temperature increases conductivity, thus permitting the use of higher current density; reduces the tendency of H to cling to the surface of the cathode; aids more uniform distribution of cathode deposit; increases size of crystals, giving a softer, open grain deposit; and decreases polarization, thus affecting throwing power. Use of conducting salts reduces resistance of the solution, permitting the use of higher current density; permits the use of lower voltage, preventing the formation of "trees" and rough deposits; increases cathode polarization, thus improving throwing power; and, in the case of copper sulphate and silver cyanide solution, it increases throwing power by increasing conductivity. High metal-ion concentration produces large crystals and is not the best throwing power available. Low metal-ion concentration is favorable to cathode polarization and, therefore, good throwing power. Methods for practical control for plating to specification are given. CBJ (7a)

The Effect of the Precipitated Structural Constituents on the Protective Action of Anodically-produced Oxide Layers on Aluminum Alloys (Ueber den Einfluss der primär ausgeschiedenen Gefügebestandteile auf die Schutzwirkunganodisch erzeugter Oxydschichten auf Aluminiumlegierungen) H. RÖHRIG. *Korrosion u. Metallschutz*, Vol. 15, Jan./Feb. 1939, pp. 32-35. Research. In an anodically-produced protective layer on Al, all structural inhomogeneities can be related to those in the basis metal, and the heterogeneous structural constituents of Al and its alloys are also oxidized just as Al itself; only Si seems to be excepted. In examining the effect of the composition, size and shape of the precipitation on the protective action, it was found that corrosion starts directly at the transformation products precipitated in the oxide layer. Coarsely precipitated impurities (especially if they span the entire thickness of the layer) impair the protective action much more than finely distributed precipitates. If a piece is plastically deformed, the brittleness of the heterogeneous constituents may reduce the value of the protection of the oxide layer. See also *Metals and Alloys*, Vol. 9, Nov. 1938, p. MA 659 R/9. Ha (7a)

Bright Nickel Plating. O. A. STOCKER. *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 26, Feb. 1939, pp. 111-121. Practical. The lustre of most bright Ni deposits increases with thickness. To secure bright deposits as thin as 0.0002 in. directly on the basis metal, the latter must be color buffed before plating. Steel having a good rolled finish needs no polishing if the Ni deposit is to be thicker than 0.0005 in. The adherence and ductility of bright Ni is not so good as that of dull Ni. Some bright Ni deposits, however, are ductile enough to withstand mild forming operations. Rubber linings for tanks must be specially compounded if contamination of the bath is to be avoided. Some baths when filtered lose part of their brightening constituents. The anode bags, if of cloth, must be made of unsized material. Anode bags now available include woven glass bags and bags of cloth with an inner lining of filter paper. The author also discusses wetting agents, impurities in the bath and methods of purification, and lists 33 precautions that should be observed in Ni plating. AB (7a)

Purifying of Bright Nickel Solutions. LOUIS WEISBERG. *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 26, Feb. 1939, pp. 122-123. Practical. Organic contaminants may be removed by filtration through activated carbon, or chemically, by oxidation with $KMnO_4$ or chlorine. The latter is preferable, as it introduces no foreign material into the bath. Liscomb's method (precipitation of $Fe(OH)_3$ in the bath) is chiefly useful for removing metallic contaminants, such as Zn, Cu, Pb, Cr. Cu and Pb can be plated out of a bath at a pH of 2 and a current density of 2 amp./ft.^{2}, and Fe and Zn at a current density of 5 amp./ft.^{2} 200 amp./hr. per 100 gal. of bath is usually required for purification. Agitation of the bath with finely divided Ni will precipitate Pb and Cu. Trivalent Cr is as harmful to a Ni bath as Cr^{VI}. It is removed by first oxidizing it to Cr^{VI} by electrolysis with Pb anodes and then precipitating Cr^{VI} with $PbCO_3$. Excess Pb is removed with powdered Ni or by Liscomb's method. AB (7a)

Hard Chromium-plated Tools (Hartverchromte Werkzeuge) W. JAEKEL. *Maschinenbau Betrieb.*, Vol. 18, Jan. 1939, pp. 10-11. Practical. Hard Cr-plating is the designation of the plating process that dispenses with the use of an intermediate layer, so that the hardness of the Cr coat becomes fully effective. The

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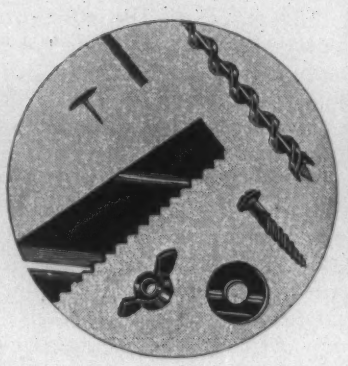

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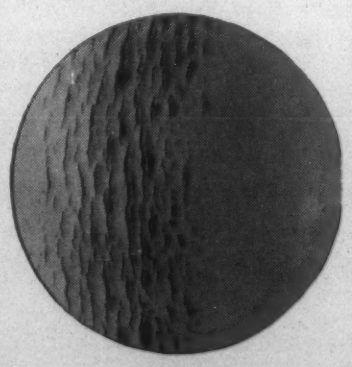

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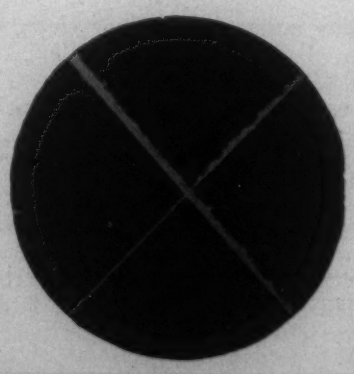

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anode consists of Pb. The Cr coat improves the wear resistance of tools, increasing their lives 10 times. Lower grade steels can be used. The thickness of the layer (0.05-0.1 mm.) is less critical than its density and smoothness, which affect friction and heat. Some tools can be ground so that the new edge shows a perfect Cr coat. Where this is not possible a thin coat is applied and repeated after grinding. Worn gages can be repaired by hard Cr-plating. Cr-plated cold rolls last about 8 times longer than untreated ones, and produce smoother sheets and strips. Shafts and other running surfaces are treated similarly for better wear.

7b. Non-Electrolytic Methods

Pickling of Strip Steel from the Metallurgical Point of View. H. P. MUNGER. *Iron Steel Engr.,* Vol. 16, Feb. 1939, pp. 58-67. Practical. Scale consists of 3 layers: The outermost layer, approximately Fe_2O_3, has a velvety appearance and a black glassy fracture; the middle layer is magnetic iron oxide, Fe_3O_4, which is black and has a crystalline fracture; the layer next to the base metal, approximately FeO in composition, is porous and consists of minute cubic crystals. When an acid solution is brought into contact with Fe covered with a normal scale, several electrolytic cells are therefore possible. The FeO phase decomposes at 1065° F. to Fe_3O_4 crystals in a matrix of finely divided Fe in Fe_3O_4. This condition is favorable to rapid reaction since the e.m.f. of this cell is high and the distribution permits many such cells. Prolonged tempering at 1020° F. coalesces the Fe particles, causes fewer cells and decreases the rate of solution in acid. The mechanism of pickling probably involves the solution of this ferrous phase and the mechanical detachment of the remaining oxides from the base metal. Controlling the atmosphere of heating furnaces not only reduces scaling but prevents over-oxidation of the scale to higher oxides. An increased proportion of ferrous oxide in the layer of scale promotes rapid effective pickling. Sulphuric acid is used for pickling because of its lower cost and the pickling bath usually contains 3-15% acid. The Fe content varies from a very low value in a fresh bath to 20-25% $FeSO_4$ (2.5 lbs./gal.) in an old one, the temperature varies from 150°-210° F. Agitation is important so that fresh acid is brought in contact with the surface to be pickled and spent acid and loosened scale are removed. In pickling, the acid penetrates the scale and dissolves the FeO phase, thus loosening the bond between the scale and base metal. This permits the scale to be lifted from the steel surface by the evolution of H and by the agitation of the bath. Organic inhibitors form positively charged colloids, which are adsorbed at the surface of the steel, thus over-pickling is prevented by inhibiting the discharge of H ions. This process also diminishes the formation of blisters and hydrogen embrittlement. A rotary coil pickler has been developed for handling loose wound coils that are rotated on a mandrel in the acid tank, while the solution is circulated by a motor-driven propeller, with a flow at right angles to the rotation of the coils. The rotary pickler has 4 stations: Loading, pickling, rinsing in cold water, and oiling in hot water-soluble oil solution. The advantages of the rotary pickler are: Low first cost, minimum requirement of space and equipment, simplicity of operation and adaptability for handling coils of varied width and gauges. Continuous strip pickler consists of an uncoiler, roller leveller, shear, stitcher or welder, looping pit, pinch rolls, pickling tanks, rinse tank, hot water tank, air dryer, pinch rolls, looping pit, shear and recoiler. Pickling procedure with this type of equipment is outlined. Advantages of modern continuous strip pickler are: (1) Development of the processor to uncoil hot-rolled strip without objectionable cross breaks, (2) more rapid and uniform pickling owing to the working of the scale-steel bond, (3) stitching of successive coils together instead of welding, (4) use of looping pits to eliminate unnecessary delays, (5) rubber and brick lined tanks instead of wooden tanks, (6) rubber coated steel hoods to remove fumes and water spray to remove acid droplets from exhaust vapors, (7) no rolls or bearings in the acid solution, (8) tanks above floor line making leakage easily detected, (9) dual sewer system for separating strong acid and weak acid, and (10) electrical system for controlling speed, tension and temperature. CBJ (7b)

Piston Rings for Automobiles (Kolbenringe für Autobahnbeanspruchungen) HANNS MUNDORFF. *Automobiltech. Z.,* Vol. 42, Feb. 15, 1939, pp. 62-64. Descriptive. In order to avoid harmful consequences of increased surface pressure on piston rings, the following surface protection methods have been developed: (1) Coating with low-melting metal (Sn). This is successfully applied to pistons proper; the rings are subject to greater wear. (2) Rustproofing treatment of ring surface, *e.g.* in hot phosphate solution. A thin porous phosphate coating is formed, which holds the oil and reduces tendency to seizing. (3) Transformation of surface into ferrous oxide (ferrox-finish). This coat acts as a polishing agent on the cylinder and ring sliding surface; it eases running-in and reduces danger of seizing. RPS (7b)

Barrel Finishing of Metal Products. H. LEROY BEAVER. *Products Finishing,* Vol. 2, Nov. 1938, pp. 24-31; Dec. 1938, pp. 26-30; Vol. 3, Jan. 1939, pp. 28-34; Feb. 1939, pp. 18-24. Discussion. Cleanliness is essential in barrel burnishing. Use of sulfonated fatty alcohols in conjunction with cleaning solutions is considered. Barrel burnishing operations in England are described. Factors in the finishing of Zn and Al die castings by the barrel method are discussed. Bright high finishes are difficult to obtain on parts that have been annealed too soft. Grinding down an uneven surface by barrel burnishing is uneconomical. Fine grained steels aid in producing smoother surfaces. Die marks are hard to remove by barrel burnishing. So far as steel parts are concerned, little can be done by way of barrel operations to overcome troubles due to slag inclusions or porous spots, but brass or Cu parts containing these defects can often be worked to smooth over the bad areas. Acid solutions that penetrate into defects will react with the cleaners used in burnishing operations to form gases that give rise to defects in the plating. Thorough neutralization of the acid and rinsing are recommended. PCR (7b)

The Corrosion Stability of Hot Galvanized Coatings on Steel. Theoretical Considerations from the Practical Viewpoint (Ueber die Korrosionsbeständigkeit feuerverzinkter Überzüge auf Stahl. Theoretische Erkenntnisse im Blickfeld der Praxis) CURT MARENSKY. *Kalt-walz-welt,* Dec. 1938, pp. 89-92. General. Coatings obtained by hot dipping are at least as good as Zn coatings obtained by other methods. Thickness of coating has the greatest effect on durability. Under known atmospheric conditions the durability of the protective coating can be calculated from its thickness. All other components, such as composition of alloy layer, purity of zinc, etc., are of minor influence. The intensity of corrosive attack varies with the atmospheric conditions. For withstanding severe corrosion, the application of thick layers is advised from the economic point of view. The Zn coating should not be too thick, to avoid mechanical damage of coating resulting from fabrication. The formation of the natural oxide and carbonate protective layers does not impair the coating as regards its atmospheric stability. Suitable painting is a valuable supplement to the corrosion protection of Fe by Zn; Zn can thus be saved by using thinner Zn coatings without impairing the corrosion resisting properties. By reasonable cooperation between producer and consumer of zinced products, a far-reaching adaption of zincing to various practical needs can be reached. GN (7b)

Plastics over Metal. C. H. WHITLOCK (Firestone Tire & Rubber Co.) *Product Eng.,* Vol. 10, Mar. 1939, pp. 107-108. Descriptive. Metal parts that have to possess strength and rigidity with lightness and good appearance are conveniently made of a metal core over which a firmly adhering, more or less thick coat of molded cellulose acetate is laid. Metal parts must first be lacquered (single coat) to give a uniform color. particularly if the basis metal has been spot-welded. The problems of securing better adhesion of the molded acetate has yet to be solved; for the present, design should include provision for mechanical anchorage of the coating. Metal parts should not have shadow-forming ribs or depressions for stiffness; stiffeners should be welded-on to the under side. Present press equipment is available for areas up to 20 in. x 20 in., or a maximum weight of molding material of 2 lbs. Acetate covering is not limited to panels and sheets. In the newer automobile gear shift levers mounted on the steering column, the knob and rod is an unfinished forging covered with cellulose acetate. Formerly, the forged rod was upset and threaded at one end and the plastic knob with threaded insert screwed on. Other thermoplastic materials than cellulose acetate may be used. Ha (7b)

Present Status of the Enamelling of Steel and Cast Iron (Heutiger Stand des Emaillierens von Stahl und Gusseisen) L. VIELHABER. *Stahl u. Eisen,* Vol. 59, Jan. 5, 1939, pp. 8-12. Review. The enamelling quality of steel or cast iron depends mainly on the C content. Combined C in cast iron, especially at the surface, may cause blisters since the cementite reacts with the oxide in the enamel and gives off CO or CO_2. A Si content above 2.7% helps overcome this by forming more graphitic C. A low C content is desirable in steel sheet. A slight roughening of the surface of both sheet steel and cast iron improves the adhesion of the enamel. The surface of the sheet should be cleaned and pickled; annealing also helps to give better adhesion. Steel sheet should be low in Si for the best adhesion. Various enamelling compositions are mentioned, and firing conditions and defects discussed briefly. SE (7b)

Factors Controlling Phosphatization (I fattori che regolano la fosfatazione) O. MACCHIA. *Ind. Meccan.,* Vol. 21, Jan. 1939, pp. 23-27. Review of the principal methods and their special applications and advantages. The free acidity of a hyperacidic phosphating solution must be maintained between definite limits for good results, the protective value depending largely on temperature and concentration of the solution applied; presence of a biacidic phosphate usually improves the phosphate layer. Best results are obtained with a manganous biacid phosphate content higher than 80%. Finishing coatings of lacquer are discussed. 91 references. Ha (7b)

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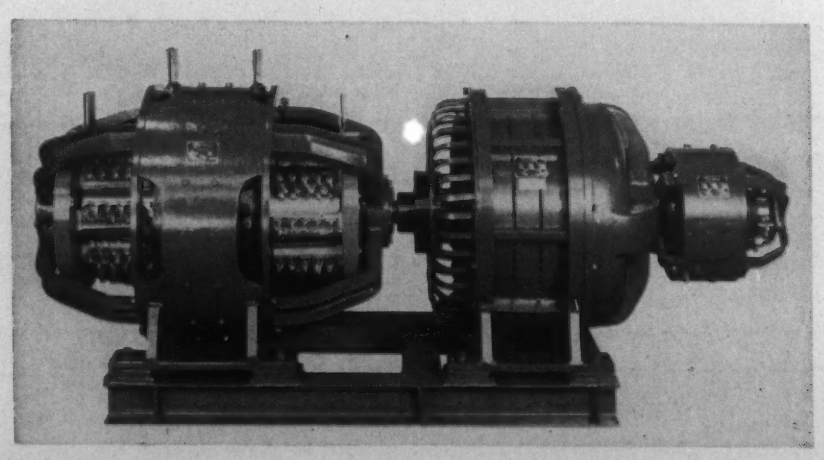

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8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analaysis.

W. A. TUCKER, L. S. REID

AND G. R. HARRISON,

SECTION EDITORS

Electromagnetic Wire Rope Testing (Elektromagnetische Drahtseilprüfung) SVERE SCHLEIP. *Doctor's Thesis, Tech. Hochschule Berlin,* 1938, 25 pp. Descriptive. An apparatus was devised for non-destructive testing of wire rope, combining high sensitivity and rapid applicability. Either a storage battery or a d.c. circuit may be used as current supply. The pole shoes of the electromagnet are fitted to the rope and can be unfastened; they possess fitting parts to make the apparatus applicable to all rope diameters. The commonly used differential coil to be wound around the rope is replaced by a shell-like coil parted in the rope direction. The parted pole shoes and the coil therefore make possible easy application of the apparatus to the rope. The combination of d.c. field and swinging coil used as a measuring coil guarantee high sensitivity both at rest and at high measuring speed. The relations between indication of defect on the one hand and dimension of fracture and its location were investigated in detail. A simple method was developed to determine the location of fractures in the rope cross-section, *i.e.* not only the location of a fracture along the rope independent of its width, but its true location could be detected. Upon passing the rope through the apparatus, the size of the voltage generated by a fracture in the single coils is observed. There are no difficulties in replacing the indicating instrument by a recording one. With small changes, the same instrument may be applied to test bars of any size, tubes, rails, wires, etc. GN (R-8)

Radiography in Industry. H. H. LESTER (Watertown Arsenal) *Bull. Am. Soc. Testing Materials,* Oct. 1938, pp. 5-13. Review. In connection with the institution of a new standing committee, Committee E-7 on Radiographic Testing, the author reviews the status of radiography in industry under the general topics of generalized historical aspect, radiography of welds and technical research. Some very interesting results from a questionnaire addressed by the author to 18 selected casting and welding producers and consumers for data or opinions based on actual observations are given. VVK (T-8)

Industrial Application of Spectrography in the Non-ferrous Metallurgical Industry. F. TWYMAN. *J. Inst. Metals,* Vol. 64, 1939, Advance copy No. 828, 10 pp. Review. Methods used for the spectrochemical analysis of non-ferrous metals are described. The accuracy obtainable by these methods is discussed. In general, the methods yield satisfactory results for elements not exceeding 4%. By means of special equipment, such as a vacuum spectrograph, it may be possible to determine non-metals such as S. JLG (H-8)

Non-destructive Testing in the United States of America. H. H. LESTER, R. L. SANFORD & N. L. MOCHEL. *Bull. Am. Soc. Testing Materials,* Dec. 1938, pp. 5-14; Jan. 1939, pp. 13-18. This paper is divided into 3 parts; Magnetic and Electrical Methods, Acoustical and General Methods, and Radiographic Methods. The term "magnetic analysis" has been adopted to denote the use of magnetic methods for the investigation and inspection of materials with respect to properties other than magnetic. While there seems to be no universal relationship between mechanical and magnetic properties for material of the same composition, 2 specimens having identical magnetic properties will have the same mechanical properties. Various methods of inspection and apparatus are described, among them those for testing steam turbine bucket wheel forgings by the General Electric Co. and the Magnaflux method. Methods have been developed for measuring thickness of enamel or paint on sheets. Of the electrical methods, the outstanding example is the Sperry apparatus for detecting flaws in railway rails. In the Acoustical and General Methods section, the following topics are discussed: Vision; hardness tests; proof tests; tests to determine cracks; testing of files, hand-saw blades, coiled springs, turbine rotor forgings; drilling, spark, etching, pressure, hammering and stethoscope tests; and testing of porcelain and glass. The section on Radiographic Methods traces the development of radiographic testing in the U. S., and presents the trend of modern thought. In the foundry the radiographic method applies chiefly to 3 general classes of castings: (1) Castings that have to withstand high stresses or that have highly stressed sections; (2) castings that may not be highly stressed but whose unexpected failure might cause losses far in excess of the value of the casting; and (3) castings that require extensive machining. Radiographic testing is used extensively in welding. Other applications are discussed and the activities of industrial radiographic committees enumerated. VVK (T-8)

Modern Sheet Testing (Neuzeitliche Feinblechprüfung) W. PÜNGEL & H. KAYSELER. *Kalt-walz-welz,* Jan. 1939, pp. 1-4; Feb. 1939, pp. 9-13. Descriptive. A brief survey is first given of the common German standard sheet testing methods, as specified in DIN 1623, and of others developed to characterize sheet material, such as the cupping-tensile test and the cupping-widening test of Siebel-Pomp, and others. The tensile and bending test, though characterizing certain properties of a sheet, give no information on drawability. The cupping tests of Erichsen, Olsen and those mentioned above test the material in a single draw and, therefore, permit no definite conclusion on the behavior on drawing in several draws. To this end the authors developed a wedge drawing-cupping test in which wedge-shaped samples of definite dimensions are drawn through a prismatic die. The Ericksen values are determined at various parts of the sample thus deformed with different degrees of cold work. These values are related to the Erichsen value of the non-deformed as-delivered sheet. The results of recent investigations with this method on plain low-C steel sheets, acid resisting Cr, Cr-Ni and Cr-Mn steel sheets and brass sheets are given; these demonstrate good agreement between the testing results and practical behavior, whereas the common cupping test frequently leads to absolutely different conclusions on the practical behavior. The authors further developed a new device for determination of the true bending number on reversed bending. The common bend testing method leads to large fluctuations in results with thin sheets, and particularly with sheets of a certain stiffness. By applying a special guide on the bending roll, the testing sample tightly adheres to the bending jaws. The fluctuations of the bending numbers are thus reduced to a minimum. GN (T-8)

Damping of Wires (Die Dämpfung von Drahten) H. LÜTTGERDING. *Mitt. Wöhler-Inst.,* No. 35, 1939, pp. 7-55. Research. The Föppl-Pertz torsional damping tester has been redesigned to take wire specimens of 0.2 mm. diameter. Justification for the design and evidence of its sensitivity are given. Damping data and curves for piano wire and a variety of high C steel wires, wires of duralumin of various compositions, Aldrey, Al with 3½% Cu, commercial Al, and commercial Cu, some in annealed as well as cold drawn condition, are given. Hard drawn wires usually gave S curves with generally good agreement among duplicates; annealed wires gave parabolic curves, with greater variation. The results for duralumin were prone to give irregular curves, with poor agreement among duplicates. The variety of materials used was chosen more to check the apparatus than to determine the properties of the materials, the latter being about what one would expect from previous studies of larger specimens. HWG (T-8)

Hardness Measurements on Electrolytic Chromium Coatings (Härtemessungen an galvanischen Chromüberzügen) J. FISCHER. *Oberflächentech.,* Vol. 16, Feb. 21, 1939, pp. 31-32. Review. The unreliability and absolute inaccuracy of measuring the hardness of thin electro deposits by impression in the normal manner is explained and illustrated by examples of Cr deposits on different materials, both softer and harder than Cr. Relatively reliable determination of hardness of Cr films can be made by scratching the film with a diamond point under a definite load; 40 g. proved

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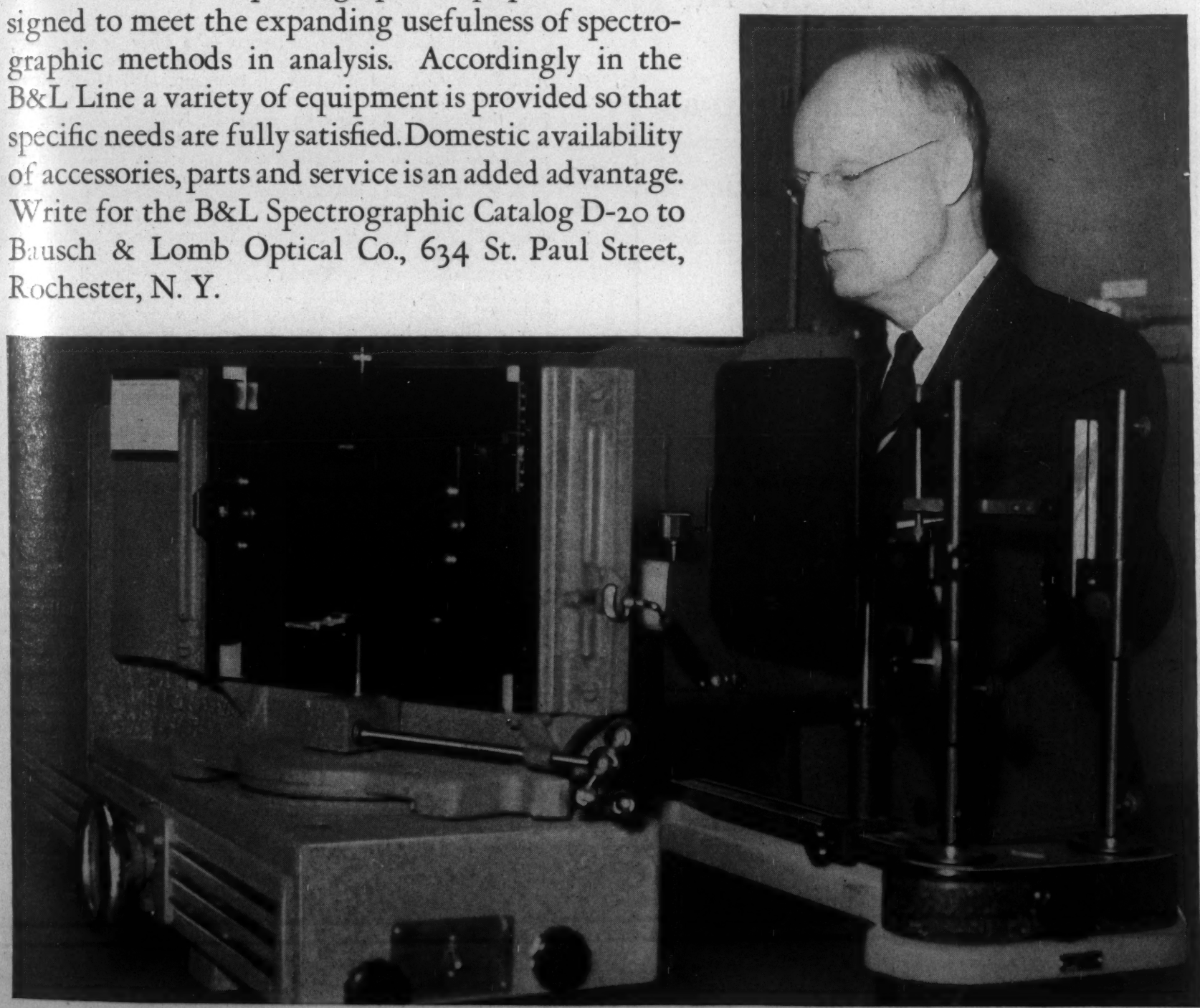

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to be best, but the Cr film has to be at least 0.020 mm. thick. The width of the scratch gives a relative measure of hardness, but it must be determined under definite conditions of illumination; otherwise, different values for the width are obtained. Ha (T-8)

New Method of Measuring Deflection in the Transverse-loading Test of Cast Iron. A. I. KRYNITSKY & C. M. SAEGER, JR. (Nat. Bur. Standards) *Bull. Am. Soc. Testing Materials,* Mar. 1939, pp. 23-24. Descriptive. A new method of measuring deflection in the transverse-loading of cast iron is described. The maximum error in reading deflections is less than ±0.002 in. The principal advantages of the method are that the readings are made entirely independently of the testing machine and supporting fixtures, and the measurements can be continued up to and including the breaking load without danger to delicate instruments, such as an extensometer or a dial micrometer. Examples are given. VVK (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

The Expanded Wöhler Diagram—the New Stress Diagram (Das erweiterte Wöhlerbild, das neue Spannungsbild) C. VOLK. *Metallwirtschaft,* Vol. 17, Nov. 4, 1938, pp. 1167-1169. Review. From the work of J. B. Kommers on damage caused by overstressing, the author develops an expanded Wöhler diagram. The expanded diagram consists of adding lines of equal decrease in endurance limit to the standard S-N curve; *i.e.* all combinations of overstress and cycles that result in damage to the specimen, so as to decrease the endurance limit 10%, are on one line. Using the expanded Wöhler diagram, the author develops a stress diagram. Two expanded Wöhler diagrams for a various range of stress conditions, say, for example, one with a minimum stress of 20 and one with a minimum stress of 2, are plotted. Another plot, having minimum stress as abscissa and maximum stress as ordinate, is then made. Values, such as virgin endurance limit, new endurance limit due to damage, etc. are carried over from the expanded Wöhler diagram and plotted on ordinates representing, in this case, minimum stresses of 20 and 2. Straight lines joining these points will then allow the determination of endurance limit for other minimum stresses as well as the damage caused by various combinations of stress and cycles in overstressing. GA (8a)

Changes in the Crystal Structure of Steel during a Fatigue Test (Die Veränderungen des Kristallzustandes von Stahl bei Wechselbeanspruchung bis zum Dauerbruch) F. WEVER, M. HEMPEL & H. MÖLLER. *Stahl u. Eisen,* Vol. 59, Jan. 12, 1939, pp. 29-33. Original research. A low, 0.02% C steel was tested in an alternate bending fatigue machine and after a number of reversals of stress above the endurance limit. X-ray crystallograms were taken to detect changes in lattice structure. A search was also made for cracks by the magnetic powder method. Before cracking was observed, slight local deformation or slipping on the planes of certain grains was noticed, this being detected by a thickening of the spots on the X-ray spectra. Cracks were found long before fracture took place. At this time, the X-ray showed no further changes in the lattice. Immediately before fracture, however, greater crystal deformation was indicated by the X-ray. This appeared to have been caused by rubbing and deformation at the cracks. This severe deformation might thus be a result of the cracking rather than a cause. Hence, this severe lattice distortion could not be used to predict fatigue failure since it occurred only when fracture was very imminent. [This result is in harmony with test reports for steel and for lead.—H.F.M.] Se (8a)

Fatigue Tests of Butt Welds in Structural Steel Plates. W. M. WILSON & A. B. WILDER. *Univ. Illinois Bull.,* Vol. 36, Jan. 20, 1939, pp. 3-55. Research. The behavior of butt welds in C and Si steels was studied on plates ¾ in. thick and 5½-6 in. wide, welded with a manually-operated metallic arc and an automatic carbon arc process. The fatigue strength of the joints in C steel "as-welded" is reduced by the stress concentration at the edge of the weld due to change in section, and can be increased by planing off excess metal. The automatic carbon arc gave a slightly greater fatigue strength than the hand-operated metallic arc in C steels. The fatigue strength of the filler metal was less than that of the base plate for the Si steel, but this depends to a certain extent on the type of electrode used. Peening the beads had practically no effect, and stress relieving by heat-treatment had

little effect on the fatigue strength of the welds. The ratio of the fatigue strength to the static tensile strength was about the same in the "as welded" condition as it was for a plate in a double-strap riveted joint, both in C and Si steels. C steel welds showed an appreciable increase in Rockwell B hardness in the heat-affected zone of the base plate, except for the automatic carbon arc and stress-relieved welds; Si-steel welds had a greater hardness in the heat-affected zone than C-steel welds, but they were not excessively hard. The weld metal in Si steel specimens was not so hard as the heat-affected zone of the base plate. The weld metal in C steel specimens gave hardness values equal or slightly exceeding the values obtained in the heat-affected zone of the base plate. Photomicrographs indicate a variety of structures in the heat-affected zone of the base plate and weld metal, depending on heat treatment. Peening followed by recrystallization destroys the last trace of original columnar structure. The macrostructure is related directly to the microstructure, and indicates various zones in the specimen. The chief factors governing fatigue failure in C steels are a change in section (stress raiser) and the fatigue strength of the original unaffected base plate. Low fatigue strength of the weld metal and changes in section seem to be about equally important as tending to cause fatigue failure in Si steels. The overheated zone was adjacent to the path of failure in Si specimens; grinding the surface of Si steel welds thus did not increase the endurance limit of the specimens tested. Testing methods and instruments are described in detail. Ha (8a)

Fatigue Failures on Chamfers of Shafts and Axles and their Avoidance. (Dauerbruchgefahr an Hohlkehlen von Wellen und Achsen und ihre Vermeidung) A. THUM & E. BRUDER. *Deutsche Kraftfahrtforschung,* No. 11, 1938, 10 pp. Research. Experiments were made to determine the decrease of fatigue strength because of notch effects of shoulder and anti-friction bearing seat. The decrease upon the concurrence of these 2 notch effects is not essentially larger than when only one of them is present, *i.e.* a bearing situated at a shoulder does not possess a much higher notch sensitivity than a bearing on a smooth shaft. The notch-effect data of shoulder, anti-friction bearing and anti-friction bearing with shoulder were determined for different bearing types and various materials, such as the German standard case hardening Cr-Ni steel VCN 15, the steel St.C. 35.61 and 2 Cr-Mo case hardening steels of different melting conditions. With samples of 17 mm. diameter, a decrease of the fatigue properties as great as 50% was found, depending on the notch sensitivity of the materials. With samples of larger diameter a still higher decrease of the fatigue strength can be expected, as the investigations by Buckwalter & Horger *(Metals and Alloys,* Vol. 9, Feb. 1938, p. MA 103 L/2) show. By constructive improvements (relief of notches at shoulder and bearing), an increase of the fatigue properties up to 15% can be attained. A still larger improvement can be effected by cold rolling the bearing seat and shoulder. This improvement amounted to 55% with St.C. 35.61 upon cold rolling with a profile roll of 1.2 mm. radius. In applying these results to practical cases, the effects of the other structural parts in connection with those investigated naturally should be considered. GN (8a)

Fatigue in Structural Steel Plates with Riveted or Welded Joints. B. P. HAIGH & T. S. ROBERTSON. *Inst. Naval Architects,* Adv. Copy, 1939, 33 pp. Research. Cracking is investigated experimentally in samples cut from riveted or welded seams and in samples of structural steel without joints but with rolled, corroded or deeply pitted surfaces, in a testing machine that applies measured loads, alternating, reversing and pulsating (varying from minimum to maximum in the same direction) throughout the whole length of the test piece. Failure occurs by cracking under severe ranges of load, or by plastic yielding followed by cracking under severe maximum loads. Samples with turned and well-finished surfaces give limiting ranges of stress that give a basis for determining optimum safe values attainable only under ideal laboratory conditions, while samples welded by machine with automatic control give values close to the optima for rolled plates, and hand-welded samples give lower strengths. Butt welds resist wider variations of stress than fillet-welded lap joints. JWD (8a)

Recent Developments in European Research on Fatigue of Metals. RICHARD P. SEELIG (Powder Metallurgy, Inc.) *Bull. Am. Soc. Testing Materials,* Oct. 1938, pp. 23-30; Dec. 1938, pp. 15-22; discussion by H. F. MOORE (Univ. Ill.) Dec. 1938, pp. 22-23. Review of recent fatigue research from English, German, Austrian, French, and Polish publications supplemented by the author's own experiments carried out abroad. The survey pertains to various branches of fatigue research, such as theory, testing methods and apparatus, and actual test results. The latter group includes contributions to the problem of factors influencing the fatigue limit, such as, notch-effect, shape-effect, corrosion, method of manufacture, etc. The trends in European research are: An increase in the study of the notch effect, a decrease in the attention to the so-called short-time tests, a tendency toward standardization and a tendency toward testing full-size and shaped structural parts. 60 references. VVK (8a)

2 Metallography

Structure and Constitution. Metallographic Equipment.

J. S. MARSH. SECTION EDITOR

New Experiments and Viewpoints for Explaining Metallic Conductivity (Neuartige Experimente und Anschauungen zur Erklärung der metallischen Leitfähigkeit) E. JUSTI & H. SCHEFFERS. *Metallwirtschaft,* Vol. 17, Dec. 23, 1938, pp. 1357-1364. Review. A summary of experimental work on the mechanism of metallic conduction carried on at the Physikalisch-Technischen Reichsanstalt, with conclusions drawn therefrom and prefaced by discussion of the electron gas theory of electric conductivity and its difficulties. Resistance measurements at low temperatures and in varying magnetic fields on high purity single crystals of Au, W, Al and Pb are reported. Measurements indicated that the resistance of Au (f.c.c. lattice) increased with increasing field strength without reaching a saturation value, as demanded by the modified electron gas theory of Sommerfeld and Frank. Repeated experiments indicated that the increase in resistance also depended upon the angle between the direction of the magnetic field and the axis of the Au crystal. The discovery of this galvano-magnetic anisotropy in simple regular cubic lattices shows that metallic conduction is not a function of an isotropic electron gas but of crystallographically anisotropic electrons. From resistance measurements on single crystals wherein the current direction corresponded with some low indexed direction, such as a cube edge [100] or cube diaganal [100] and the magnetic field was perpendicular to the current direction, it was possible by rotating the crystal to construct polar diagrams of resistance increase, which would have a symmetry related to crystal orientation. An anisotropy factor, which is defined as $\Delta \rho_{max.}/\Delta \rho_{min.}$, where $\Delta \rho_{max.}$ is maximum increase in resistance and $\Delta \rho_{min.}$ the minimum increase in resistance at a given temperature and field strength, was found to increase with increasing field strength or decreasing temperature for Au. Measurements on W crystals (b.c.c. lattice) disclosed that the polar diagram of resistance increase (current in [100] direction) had 4-fold symmetry with minimum resistance increase corresponding to the [100] direction and maximum increase to the [110] direction. In both cases the increase in resistance was proportional to the square of the field strength. Experiments on Al (f.c.c. lattice) revealed little anisotropy. Al seems to deviate but slightly from the electron gas theory. From consideration of the experiments on Au, W and Al, a generalization was established that in a constant magnetic field with decreasing temperature, the resistance due to the magnetic field increases, remains constant or decreases, depending upon whether the resistance increases at a constant temperature, increases at an accelerating rate, linearly or at a decreasing rate in an increasing magnetic field. The [100] polar diagram of Pb (f.c.c. lattice) showed 4-fold symmetry similar to the [100] W crystal, whereas the [100] Au crystal diagram contained 8 maxima and 8 minima. These experiments on metals with a simple crystallographic structure indicate that the theory of a free electron gas as a current conductor in no case is qualitatively correct, but rather that there are types of electrical conductivities governed by crystal structure and valence electrons. A correlation is noted between the anisotropy of the modulus of rigidity and modulus of elasticity and the electrical anisotropy of the metals studied. GA (9)

Micro-method in Radiography and X-ray Analysis. H. W. GREENWOOD. *Light Metals,* Vol. 2, Jan. 1939, pp. 8-9. Review. Micro-radiography, or the art of preparing radiographs that may be magnified about 100 diameters or more, is not as new a development as might be supposed. Heycock and Neville recognized the possibilities of such a technique about 40 years ago, although they were too hampered by crude equipment to accomplish much. The usual method is to make radiographs of very thin sections of metals, the thickness being of the order of .05 mm. In one method, the X-ray tube and camera are built to be evacuated as a unit. The tube is demountable to allow the introduction of different targets to give a range of wave lengths from 1 to 6 A.U. The combined tube and camera allow shorter exposures, since the X-ray beam is not scattered by air. The so-called Lippmann emulsion, which is practically free from grain, is used; at least the grain is not resolved at several hundred diameters. The tube is operated at 5,000 volts and 100 milliamps., and either an Al or Li window is used to prevent the cathode light from reaching the film. With this technique, photographs can be taken of the film up to 200 diameter. The advantages of micro-radiography over photomicrography lies in the information obtained about alloy homogeneity, or lack of it, and in the probable detection of very fine fissures, etc. When a picture is examined of an alloy containing elements of widely different atomic weight, the micro-radiograph shows more detail than an ordinary micrograph; and there is a further possible advantage that in some cases greater clarity would be expected where little differentiation of phases is observed under the microscope, owing to lack of selective etching, etc. A relatively new method is that of the "micro-analyzer" due to L. v. Hamos (see following abstract). In this instrument, monochromatic X-rays fall on the specimen and excite secondary radiation. This radiation is directed to a concave crystal surface and is reflected to the photographic plate. In order to excite secondary radiation, the target material is determined by the element in the alloy to be investigated. Hence, if the distribution of Cr in an alloy is to be investigated, a Cr target is used. The pattern produced on the plate is the pattern of the distribution of the element in the alloy emitting the secondary radiation. This method is capable of considerable precision, and the film or plate may be examined under the microscope to follow small changes in the concentration of the element studied. It is said that quantitative estimations of the emitting element may readily be made, and that particle sizes of the order of .000001 mm. may be detected. AUS (9)

Diffusion through Polished and Etched Copper Surfaces (Ueber die Diffusion durch polierte und geätzte Kupferoberflächen) H. CRAMER. *Ann. Physik,* Vol. 34, Feb. 1939, pp. 237-249. Research. Diffusion at the contact between 2 metals at elevated temperature was investigated, with particular attention to the condition of the surfaces in contact. If polycrystalline Au layers, deposited *in vacuo* on polished and etched Cu surfaces, are heated to 150°-500° C., they are converted to Au-Cu alloys, the Cu content of which increases with increasing temperature; the polycrystalline nature remains unchanged. No change of the lattice could be observed with Ag from 20°-500° C. Thin Zn films showed considerable oxidation above 300° C. even in vacuum; the diffusion of Cu into the ZnO layer is so strong that at 450° ZnO is practically completely transformed into Cu_2O. A similar behavior was observed for Ni on an Fe surface. Ha (9)

Diffusion Possibilities of Gases in Metals and Between Two Solid Phases (Ueber die Diffusionsmöglichkeiten von Gasen in Metallen und zwischen zwei festen Phasen) W. BAUKLOH & B. KNAPP. *Metallwirtschaft,* Vol. 17, Dec. 9, 1938, pp. 1302-1304. Review. Three different diffusion possibilities in metals, diffusion along the grain boundaries, diffusion through the lattice and surface diffusion are briefly discussed. From a survey of systems studied by others, it is concluded that in the case of metals diffusing into metals so as to form wide solid solution ranges or where there is considerable difference in atomic volume, the predominating mode of diffusion is lattice diffusion. If conditions are reversed from the above, diffusion will be characterized by grain boundary diffusion. For metal-metalloid systems, lattice diffusion prevails. GA (9)

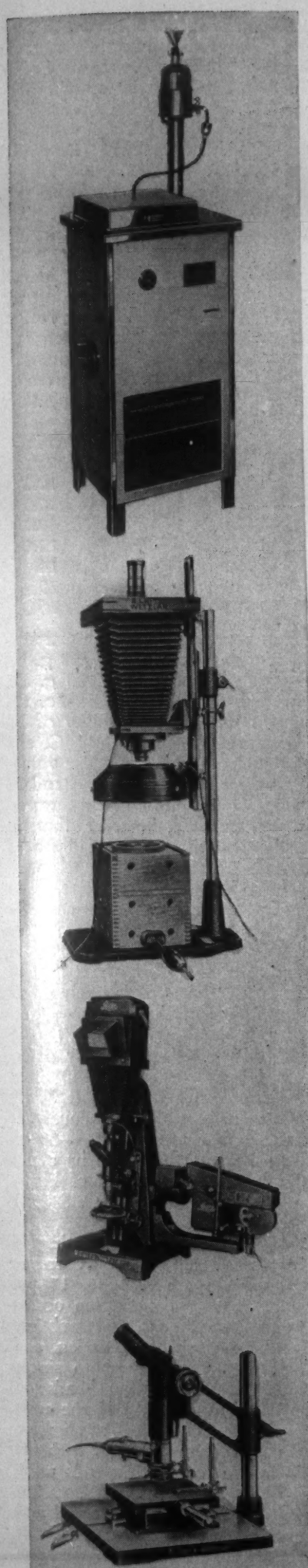
The Amorphous State of Metals (Ueber den Amorphen Zustand der Metalle) A. SCHULZE. *Metallwirtschaft,* Vol. 17, Nov. 25, 1938, pp. 1243-1248. Review and discussion, particularly of the work of J. Kramer (see *Metals and Alloys,* Vol. 9, Apr. 1938, p. MA 246 L/1) on the electrical and ferromagnetic properties of thin films. The transformation from an amorphous material to crystalline material is, as determined by conductivity measurements, irreversible. Some of the doubts as to whether amorphous films really exist are caused by the difficulty of producing 100% amorphous metal. The simplest method to form amorphous metal is to evaporate so as to form thin film. Explosive antimony produced by electrolysis is amorphous, according to X-ray analysis, and has the same physical properties and transformation temperature as amorphous Sb films produced by cathodic dusting. GA (9)

Polishing Metallic Surfaces. *Light Metals,* Vol. 2, Jan. 1939, pp. 34-35. Review. In both metallographic polishing and in other types of metal polishing, the polished surface tends to flow, giving the so-called Beilby layer. This layer is, of course, more likely to form in industrial operations where high speeds and heavy pressures are used than in properly conducted metallographic polishing, in which great care is ordinarily taken to reduce the surface flow to a minimum. Electrolytic polishing avoids all possibility of cold work on the metal surface, and the surface produced in this manner should be a true cross section of undisturbed metal, hence microscopic examination of such a surface should reveal the true condition of the metal. In ordinary polishing, the melting point of the metal is reached and this melted metal flows over the surface. Obviously, the reflecting power of a metallic sample (its degree of polish) as developed by mechanical methods will depend largely on how extensive this flow is, and in what manner it was induced. On the other hand, the electrolytic method should yield a surface that is intrinsically characteristic of the metal in question. Al of 99.998% purity has been shown to recrystallize at room temperature. In examining such a metal by a mechanical polish, the grain structure observed under the microscope may well be the recrystallized structure and not the original structure. The electrolytic method was developed by Jacquet, who has obtained very satisfactory results with Cu, Pb, Sn, Al and various alloys. The sample to be electrolytically polished is anodically dissolved so that the hollows of the surface are protected by the products of reaction, while the high points are less protected and are removed. In this manner, a sample not perfectly plane at the start approaches planar perfection as electrolysis proceeds. In the case of Al, the electrolytic solution is a mixture of perchloric and acetic acids. [For details of the method, the reader should refer to Jacquet's work (see *Metals and Alloys,* Vol. 9, Aug. 1938, p. MA 507 L/9.)] The method has been found very suitable for metallographic work, and after 10 min. of polishing, the surface produced was suitable for microscopic examination at the highest magnifications. AUS (9)

The Fundamentals of the Reactions between Gases and Metals (Ueber die Grundlagen der Reaktionen zwischen Gasen und Metallen) K. FISCHBECK. *Chem. Fabrik,* Vol. 11, Nov. 23, 1938, pp. 525-533. Theoretical discussion. A knowledge of the reaction rates and equilibrium conditions between gases and metals is important in establishing the results that can be expected under a given set of conditions. For example, diagrams showing equilibrium of Fe and its oxides are given for atmospheres of O_2, H_2O and H_2, and CO and CO_2. The increased oxidation of Fe in steam at 1000° C., as compared to air or CO_2, can be explained from the standpoint of the equilibrium conditions between the gases and metal. The oxidation occurs through diffusion of Fe and not diffusion of the gas through the oxide zone. Temporary reactions are discussed. Diffusion through the metallic lattice is explained and classified as 3 types: Substitutional, interstitial and by movement through spaces formed by missing atoms. The best type of protective coating on a metal is one developed naturally, as on Al or Cr. 26 references. PCR (9)

Diffuse Electron Patterns. J. T. BURWELL (Mass. Inst. Tech.) *J. Chem. Phys.,* Vol. 6, Dec. 1938, pp. 749-751. Original research. Diffuse electron diffraction patterns taken by reflection have, in the past, been cited as proof that the polished surfaces of metals are amorphous "Beilby layers" or very finely crystalline. In the present work 18/8 stainless steel was either (a) polished on chamois under benzene and immediately transferred to the diffraction camera, or (b) etched electrolytically in 10% oxalic acid and vacuum annealed at 1000° C. for 30 min. It was shown that the same patterns can be obtained on large-grained crystalline surfaces as on polished ones. The physical contour of the surface rather than the presence of the "amorphous" phase accounts for the diffuse electron diffraction patterns. EF (9)

Crystallography of Alloys (Kristallographie der Legierungen) F. LAVES. *Naturwiss.,* Vol. 27, Feb. 3, 1939, pp. 65-73. Survey. Of the 78 crystal structures of metals, 82% are either face-centered cubic, body-centered cubic, or hexagonal close-packed, thereby showing a tendency to form a symmetrical lattice. The coordination number (CN) is the number of nearest neighbors of an atom; 12 is the maximum CN, representing the greatest possible space utilization. 55 of the 78 crystal structures of metals have a CN of 12; 16 have a CN of 8; and only 7 have a CN less than 8. This fact shows a tendency toward maximum space utilization. The "laws" governing the crystal structure of alloys are: (1) Tendency of complicated compounds to form simple structures; (2) the homogeneity region of compounds with structures similar to elements and of ternary compounds is often very extended, while that of binary compounds is small; (3) isomorphous solution regions of elements and compounds are often very extended if the crystalline structures and lattice constants are similar; (4) certain structures are favored when the ratio of the valence electrons to the atoms approaches a characteristic value for that particular structure; (5) if the atomic radii are similar, isomor-



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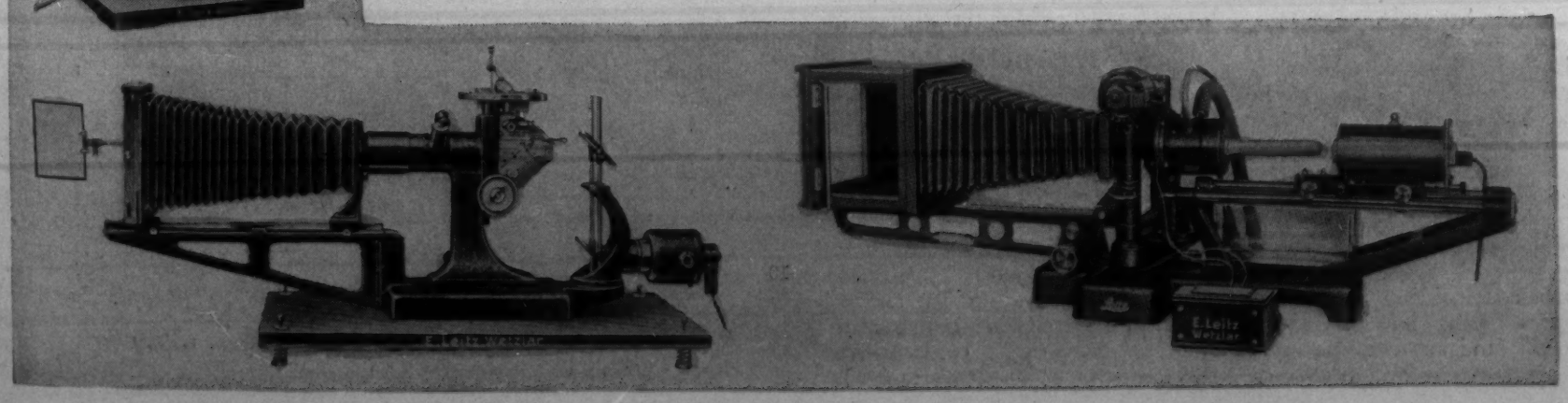

phous mixtures will exist; if the similarity is not sufficient, a superstructure may occur. The radii ratio of the alloying elements is decisive for the type of structure formed by metallic compounds. If the difference in radii is too large (over 30%), no compound will form, but the one constituent will be embedded in the other; (6) the formation of compounds naturally depends on the structure of the external valence layer of the atoms, and certain approximate rules may be set up as to what elements will alloy with each other. The lattice composition of certain compounds, such as $MgCu_2$, was discussed in detail. If only the Mg atoms of this compound are considered, they form a lattice with a Cn of 4, while the Cu atoms considered alone form a lattice with a CN of 6. These 2 lattices exist together in the compound in such a manner that the Mg atoms (considered as spheres) touch only other Mg atoms, but no Cu atoms. The lack of a definite boundary between solid solutions, superstructures and compounds is discussed. JZB (9)

X-ray Micro-analyser. L. v. HAMOS. *J. Sci. Instruments,* Vol. 15, Mar. 1938, pp. 81-87. Original research. A micro-analyser is described; it produces true monochromatic X-ray images of the surface of a sample exposed to primary X-rays. The characteristic X-rays emanating from the sample are reflected by a concave crystal mirror to form photographs of the surface. Each of the X-ray photographs represents the distribution of a definite chemical element over the surface of the sample. Some of the optical properties of such an arrangement are discussed. Micro-analysis is made possible by means of X-rays without dissipation of the sample. The application of this method to problems in mineralogy and metallography is illustrated by typical X-ray photomicrographs. 2 references. RAW (9)

9a. Ferrous

J. S. MARSH, SECTION EDITOR

Quantitative Estimation of Non-metallic Inclusions in Steel. R. HUNTER. *Metal Treatment,* Vol. 4, Winter 1938-9, pp. 177-181. Descriptive. Estimation of the cleanliness of steel samples by visual comparison of unetched sections with a series of standard micrographs is less satisfactory than inclusion counting, which does not involve the use of arbitrary standards. A simplified method in use by the Clyde Alloy Steel Co., Ltd., is described. A carefully-selected 1-in.^{2} is polished with commercial alumina and then Diamantine powder on broadcloth-covered wheels and finished by hand with magnesia on Selvyt. Etching to increase contrast is performed in 10% chromic acid solution or sometimes in boiling 1% HCl containing 0.5% inhibitor. For measurement, a 100X image is thrown on a ground glass 5 in. by 3 in., ruled with vertical lines 1/10 in. apart. Three Veeder counters are used to record the number of fields examined, the total length of inclusions, and the number of inclusions over 0.001 in. long. The length and approximate thickness of the largest inclusion is also noted. The count is recorded by 3 figures and a letter representing the number of inclusions/in.^{2}, the average length, and the length and thickness of the largest inclusion, respectively. JCC (9a)

Surface Allotropic Transformation in Stainless Steel Induced by Polishing. J. T. BURWELL (U. S. Steel Corp.) & J. WULFF (Mass. Inst. Tech.) *Metals Tech.,* Vol. 6, Feb. 1939, T.P. 1032, 6 pp. Original research. Surfaces of a steel containing 18.12% Cr, 8.94% Ni and 0.08% C were ground on 0000 emery paper, and others were given a metallographic polish. Electron diffraction from these surfaces showed the 2 diffuse lines typical of polished surfaces of any metal. Small increments of surface were then removed electrolytically and the surface examined by electron diffraction after removal of each increment. On both the ground and polished surfaces the material just under the surface had been transformed by the grinding from the γ to the α phase. The observable effects extended to a depth of about 4×10^{-5} cm. below the polished surface. In the first 2.5×10^{-5} cm. the material is 90% ferritic, and below 4×10^{-5} cm. it is wholly austenitic. JLG (9a)

Notes on Etching Inoxidizable Steels. J. A. VERÖ. *Roy. Hung. Palatin-Joseph Univ. Tech. Econ. Sci. Pub., Dept. Mining Met.,* Vol. 10, Part 1, 1938, pp. 183-190. In German, with English Synopsis. Research. Reagents for etching of austenitic acid- and heat-resisting steels were compared. Aqua regia and hydrofluoric-nitric acid solutions did not give entirely satisfactory results in distinguishing the constituents. Fully reliable results were obtained with anodic etching in a solution of 10% oxalic acid in distilled water at 5-6 v.; 15-30 sec. sufficed for detection of carbides, 30-40 sec. for revealing the grain boundaries. The cathode was a Pt sheet. This method is particularly useful for austenitic steels containing a large amount of Cr. A reliable solution for austenitic, ferritic, and martensitic steels containing less than 15% Cr is HCl (1.19) 30 cc., water 40 cc., crystallized cupric chloride 5 g., alcohol 30 cc. This reagent, which shows clearly grain boundaries of austenite together with twins, slip bands, and any carbides in about 30 sec., can be used cold. Ha (9a)

The Solubility of Hydrogen, Deuterium and Nitrogen in Iron (Die Löslichkeit von Wasserstoff, Deuterium und Stickstoff in Eisen) A. SIEVERTS, G. ZAPF & H. MORITZ. *Z. physik Chem.,* Abt. A, Vol. 183, Nov. 1938, pp. 19-37. Original research. The existing data on the solubility of H_2, D_2 or N_2 in Fe are critically reviewed and supplemented by new measurements following the procedure described in the papers of Sieverts & Zapf (*Z. physik Chem.,* Abt. A, Vol. 174, 1935, p. 359; see also *Metals and Alloys,* Vol. 8, Feb. 1937, p. MA 102R/3), and Sieverts & Moritz (see *Metals and Alloys,* Vol. 9, Nov. 1938, p. MA 670L/1). The determinations were made on samples of carbonyl, electrolytic, and Armco Fe (0.03% C, 0.003% Si, 0.02% Mn, 0.005% P, 0.02% S). The results obtained on the various samples are reported in full and are given equal weight in the final evaluation, disputing the contention of Baukloh & Müller (see *Metals and Alloys,* Vol. 9, Oct. 1938, p. MA 618R/2) that the results of solubility determinations depend on the type of samples used. The new values, at 760 mm. Hg pressure, of the solubility of H_2 in Fe are given in the Table. All gas solubilities are at normal temperature and pressure.

Temp. ° C.	Phase	cc. H_2/ 100 g. Fe	Temp. ° C.	Phase	cc. H_2/ 100 g. Fe
500	α-Fe	0.6	1350	γ-Fe	10.1
700	α-Fe	1.8	A_4	γ-Fe	10.5
A_3	α-Fe	3.0	1400	δ-Fe	10.1
900	γ-Fe	4.7	1450	δ-Fe	11.0
1100	γ-Fe	7.0	m.pt.	δ-Fe	14
1200	γ-Fe	8.2	1520	melt	25
1250	γ-Fe	8.8	1550	melt	26

The solubility of H_2 in Fe changes discontinuously at the temperature of the α Fe $\rightarrow$ γ Fe transformation by —0.4 cc. H_2/100 g. Fe, and at that of the melting point of Fe by 11 cc. H_2/100 g. Fe. The solubility of D_2 in Fe is lower than that of H_2 in Fe, the difference increasing with the temperature. The solubility of N_2 in Fe was newly determined at temperatures above 1200° C. and at the pressures of 744, 754 and 757 to 760 mm. Hg. The values scattered considerably and could not be reduced to a standard pressure on account of the uncertainty of the effect of pressure on the solubility of N_2 in Fe. It was established, however, that, as in the case of H_2, the curve of the solubility of N_2 in Fe as depending on temperature, consists of 4 branches. The temperature coefficient of the solubility of N_2 in α Fe is positive, even though the known solubility values for this phase are not accurate (see *Metals and Alloys,* Vol. 3, May 1932, p. MA 146). For γ Fe, the values 19.2 and 18.2 cc. N_2/100 g. Fe at 1200° and 1300° C., respectively, are believed correct. Thus, the temperature coefficient of the solubility of N_2 in γ Fe is most likely negative, as in the systems Pd-H_2 and α Mn-H_2, being about —1 cc. N_2/100 g. α Fe/100° C. That for δ Fe is about 2 cc. N_2/100 g. δ Fe/100° C. In the melt, the solubility of N_2 was newly determined as 24.6 and 26.7 or 27.9 cc. N_2/100 g. Fe at 1540° and 1560° C., respectively; its temperature coefficient is most likely positive. The solubility of N_2 in Fe changes discontinuously at the temperature of the α Fe-γ Fe transformation by about —20 cc. N_2/100 g. Fe, at that of the γ Fe-δ Fe transformation by about —9 cc. N_2/100 g. Fe, and at that of the melting point of Fe by about 14 cc. N_2/100 g. Fe. ORS (9a)

Structure of Iron after Drawing, Swaging and Elongating in Tension. CHARLES S. BARRETT & L. H. LEVENSON (Carnegie Inst. Tech.) *Metals Tech.,* Vol. 6, Feb. 1939, T.P. 1038, 17 pp. Original research. A specific type of grain fragmentation occurs in swaged and drawn Fe wires and tensile specimens, and doubtless in all Fe rods, wires and tubing formed by cold deformation, and in grains from a diameter of 0.02 mm. or smaller up to single crystals. It consists of the formation of deformation bands on crystallographic planes of the forms (100) and (111) in the early stages of deformation. The lattice in a band rotates away from the parent orientation an amount that gradually increases with the deformation. The direction of this lattice rotation depends upon the crystallographic plane on which the band is formed. After greater deformation, the parallel sets of bands become curved and also rotate into a position parallel to the wire axis, while the lattice within each band rotates to bring a [110] direction parallel to the axis. The curving of the bands, their interpenetration, and the lattice rotation within them are thus able to generate a [110] fiber texture in a single crystal or grain such that fragments possess all azimuthal positions around the wire axis. The "elongated grains" seen in longitudinal sections of Fe wires are frequently deformation bands. Deformation bands account for the failure of some investigators to get conclusive results regarding the slip directions and slip planes from investigations with tensile specimens. 21 references. JLG (9a)

The Niobium-iron Diagram. *Metallurgist (Suppl. Engineer)* Oct. 1938, pp. 164-165. Extended abstract of paper by R. Vogel & R. Ergang in *Arch. Eisenhüttenw.* See *Metals and Alloys,* Vol. 10, Mar. 1939, p. MA 171 R/7. VVK (9a)

9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

New Investigations on Chromium and Manganese (Neuere Untersuchungen über Chrom und Mangan) A. SCHULZE. *Metallwirtschaft,* Vol. 18, Jan. 13, 1939, pp. 35-41. Review and discussion of new work on the physical and constitutional behavior of the metals Cr and Mn. Electrical, dilatometric and magnetic data as well as X-ray investigations are reported. Cr occurs in several allotropic modifications: α-chromium being body centered cubic, β-chromium body centered cubic with 58 atoms in a cell and γ-chromium hexagonal close packed. β- and γ-chromium have been found only in electrodeposits, and the transformation temperatures are unknown. Mn exists in 3 different modifications: The α phase, body centered cubic, has 58 atoms in the elementary cell, the body centered cubic β phase has 20 atoms while the γ phase is tetragonal. A fourth phase, β′, has been reported by Grube and co-workers but has not been confirmed by more recent work. GA (9b)

The Palladium-hydrogen System (Contribution a l'Étude du Système Palladium-Hydrogène) A. MICHEL. *Bull. Assoc. Tech. Fonderie,* Vol. 12, Nov. 1938, pp. 302-304. Review. Pd absorbs enormous quantities of H readily and, used as a basis for comparison, gives a means of studying the absorption of gases by other metals. The total quantity of gas absorbed by a metal is not as important as the manner in which the gaseous atoms enter the crystal lattice. The hardness of Pd varies widely as its H content is changed. It is the variation of the parameter and the distortion of the lattice that are responsible for the modifications of electrical, magnetic, and mechanical properties. The formation of Pd_4H resembles that of Fe_4N, except that H is inserted in the lattice in the same position as the N. The N in the Fe_4N produces hardness. WHS (9b)

The Crystal Structure of Cadmium-indium Alloys Rich in Indium. W. BETTERIDGE. *Proc. Phys. Soc., London,* Vol. 50, July 1938, pp. 519-524. Research. The solubility of Cd in In was determined by X-ray diffraction methods as 14.5 ± 0.5 atom. % at 100° C. and 4.5 ± 0.5 atom. % at 20° C. Earlier determinations, made by microscopic methods, were not sufficiently sensitive to detect the precipitation at low temperatures. JCC (9b)

Heat Content and Lattice Condition of Pyrophorically Active Copper (Ueber Wärmeinhalt und Gitterzustand von pyrophor aktivem Kupfer) R. FRICKE & F. R. MEYER. *Z. physik. Chem.,* Abt. A, Vol. 183, Dec. 1938, pp. 177-189. Original research. The preparation of pyrophoric Cu by: (1) Reduction of active CuO with H_2 at different temperatures; (2) reduction of active CuO with H_2 in presence of substances inhibiting coalescence *(Sammelkristallisation);* (3) reduction of basic Cu carbonates with H_2; (4) precipitation from an aqueous CuCl solution with Zn powder; (5) precipitation from an ammoniacal CuCl solution with $Na_2S_2O_4$; (6) sputtering Cu in a high-voltage electric spark and (7) detonation of acetylene Cu, is described in much detail. The samples so produced of pyrophoric Cu, either pure or deposited on carrier substances, were variously investigated, X-ray analytically, for particle size and lattice disturbances and, calorimetrically, for their heat content. All samples were very disperse and some very strongly active ones had, moreover, strong lattice disturbances. The heat content of one of these was found to be 3 kg. cal./mol. greater than that of normal Cu. Pyrophory of metals is not contingent on the presence of strong lattice disturbances in conjunction with fine dispersion, but may also occur in samples that are merely in a very highly dispersed condition. ORS (9b)

The Crystallization Velocity and Rate of Nucleation of Lead Alloyed with Small Amounts of Calcium, Strontium, Barium and Silver (Kristallisationsgeschwindigkeit und Kristallitenzahl von Blei bei geringen Zusatzen von Kalzium, Strontium, Barium und Silber) E. JENCKEL & H. POETSCH. *Z. Metallkunde,* Vol. 30, Nov. 1938, pp. 396-399. Experimental. The rate of nucleation and rate of crystal growth were determined for high purity Pb and its alloys with small amounts of Ca, Sr, Ba and Ag by microscopic methods. The rate of growth appeared to approach a maximum with increasing amounts of undercooling and then to decrease rapidly. The rate of nucleation always increased. The interpretation of the data is confused by the fact that the alloy additions change not only the composition of the solidifying phase, but also the amount of undercooling. Within the limits of their solid solubility, alloys either increased or decreased the rate of growth, but they all increased the rate of nucleation. The formation of any second phase increased the rate of nucleation very markedly. This effect was especially strong with the addition of 0.7 atom. % Ca to form primary $CaPb_3$. GD (9b)

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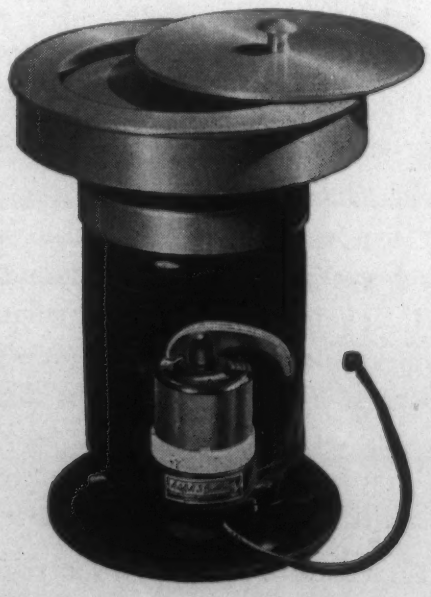

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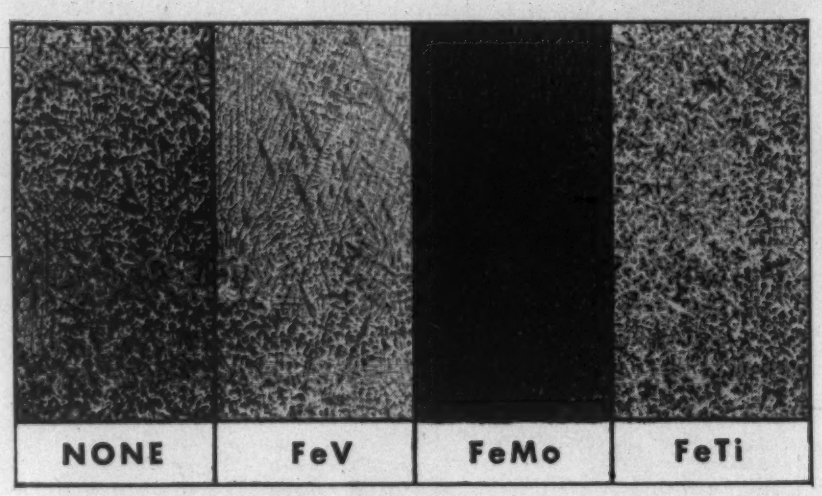

The macrographs above show the effects of different alloy additions on test ingots of .40 carbon steel made under identical conditions.

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Investigation of the Dispersion of X-rays by Copper Alloyed with Aluminum. B. M. ROVINSKIY. *Zhur. eksptl. i teor. fiz.*, Vol. 8, Jan. 1938, pp. 84-88. In Russian. Original research. A Cu-Al alloy, with 17.4 atomic % Al representing a solid solution of Al in Cu, was prepared from high-purity Cu and Al; homogenized by long annealing in vacuo; powdered with a file; reannealed *in vacuo* to remove cold-work deformations; sifted for a uniform powder size of 10 to 12μ; mixed, in the proportion of 732/100, by weight, with annealed Al powder of the same size as calibrating substance; molded to cylindrical specimens, using Zapon varnish as binder; and exposed in an X-ray diffraction camera, following the procedure described in the author's paper in *Zhur. eksp. i teor. fiziki,* Vol. 7, 1937, pp. 971-977. The X-ray spectograms were photometered with a Zeiss recording microphotometer, and the relative and the absolute intensity of the X-ray reflections were measured in a comparator. The results show that the intensity of scattering of X-rays by the Cu-Al alloy is much smaller than in the case of either pure Cu or pure Al, which is attributed to the fact that on substitution of a certain number of Cu atoms by Al atoms in the crystal lattice of Cu, the distribution function of the radial electronic density, the atomic scattering factors of Cu and Al, and the heat factor change. The heat factor of an alloy varies with its characteristic temperature which, in turn, appears to depend on the concentration of the solid solution. Measurements of the absolute intensity of scattering enable one to determine the characteristic temperature of a given alloy, to calculate its molar heat capacity at constant volume, and to give a general quantitative description of the condition of its crystal lattice. For the Cu-Al alloy with 17.4 atomic % Al, the characteristic temperature was found as 245° C. and the heat capacity as $c_v = 5.712$ cal./°C. mol. ORS (9b)

The Exact Measurement of the Specific Heat of Solid Substances at High Temperatures. Specific Heat, Electrical Resistance, Thermo-electrical Behavior and Thermal Expansion of Some Rare Earth Metals. F. M. JAEGER, J. A. BOTTEMA & E. ROSENBOHM. *Rec. Trav. Chim.*, Vol. 57, Nov. 1938, pp. 1137-1182. In English. Original research. (See also *Metals and Alloys,* Vol. 9, Apr. 1938, p. MA 252 R/2). The rare earth metals—Ce (98.8% Ce, 1% Fe, traces of Si, C, Al, Mg), La (purity not given), Nd (99.5% Nd, traces of Fe, Si, Al) and didymium (purity not given) all show a series of at least 4 reversible allotropic changes. The different phases are discerned as α, β, γ and δ states of these metals. Study of the specific heat, thermal expansion, electrical resistance and thermo-electrical behavior in relation to temperature, shows that the inner state of all these metals is at each temperature highly complicated, being characterized by the simultaneous coexistence of several of the modifications. As the transformations between these modifications occur very slowly, the "instantaneous inner state" of these metals is not one of perfect equilibrium and, therefore, depends at each temperature to a large extent on the mode and duration of their preliminary thermal treatment as well as on the time during which the samples, after treatment, are preserved for re-examination. The transition-temperatures are in all cases located between —170° C. and 720° C. The character of the accompanying retardation phenomenon is different in each case. Neodymium shows most remarkable cyclic effects, a peculiar internal thermoelectrical force and an abnormal thermal expansion within the limits of a transition interval, which indicates the physical inhomogeneity of the metal. EF (9b)

Studies on the Structure of Binary Aluminum Bronzes (Studen über den Gefügeaufbau der Zweistoff-Aluminiumbronzen) GUIDO KOCH. *Forschungsarb. Metallkunde Röntgenmetallog.*, No. 24, 1937, 71 pp. Original research. Previous work on the Cu-rich Cu-Al alloys is critically discussed. Alloys containing up to about 16% Al were investigated, chiefly by microscopic examination in which polarized light was used. Samples produced by diffusion as well as those of uniform composition were examined. Results indicated that the needle-like structure of the β' phase was brought about by twinning resulting from stresses. The polarizing microscope indicated that the β' phase was anisotropic, possibly because of stresses. A lamellar eutectoid is formed only when the transformation is $\beta \rightarrow (\alpha + \delta)$. In other instances, with more rapid cooling, the α phase is precipitated from the β_1 phase. This is because the solubility of Al in the β_1 phase is higher than that of the eutectoid 12.8% as compared with 11.92%. At higher Al content the β_1 phase is supersaturated with δ. A complete decomposition of β to give the ideal lamellar eutectoid is very difficult to produce, even with slow cooling, because the following transformations take place: $\beta \rightarrow \beta_1 \rightarrow (\alpha + \delta)$, and the $\beta_1 \rightarrow (\alpha + \delta)$ transformation is always preceded by the precipitation of α. The β' phase suggested by Smith and Lindlief was not found, and this so-called phase is attributed to the distribution of impurities in the material used by Smith and Lindlief. Quenching experiments indicated that the eutectic at which α and β are formed occurs at 1031° C. 40 references. JLG (9b)

The Acute Tin Plague. III (Die akute Zinnpest. III) ERNST COHEN & W. A. T. COHEN-DE MEESTER. *Z. physik. Chem.*, Abt. A, Vol. 183, Dec. 1938, pp. 190-198. Original research. Continuing their research on the effect of minute contents of various elements on the rate of the white Sn → gray Sn transformation (see also *Metals and Alloys*, Vol. 9, June 1938, p. MA 378 R/5; Nov. 1938, p. MA 672 L/1) the authors prepared various binary Sn alloys with 0.01 or 0.05 wt. % of the alloying element, using spectrographically analyzed Sn with 99.996 wt. % Sn from Adam Hilger, London, Mg with 99.82 wt. % Mg, Zn with 99.9995 wt. % Zn, Ni with 99.97 wt. % Ni, Cd with 99.9990 wt. % Cd, Tl prepared by the authors by electrolysis of repeatedly recrystallized Tl_2SO_4, or *ferrum reductum* previously heated in a current of H_2 purified by the method of Cohen & Bruins (*Z. physik. Chem.*, Vol. 94, 1920, p. 443). The alloys were melted and cast *in vacuo*, using a flask built up from a sphere and a tube of about 7 mm. inner diameter of Pyrex glass. After introducing weighed amounts of Sn and the alloying element, the flask was highly evacuated and sealed, the alloy was melted in the sphere and allowed to flow into the tube by inverting the flask. After cooling in air, the tube was destroyed and the Sn alloy rod was rolled down to a strip, 0.2 mm. thick, 15 mm. wide, at room temperature. This strip was kept in a closed glass tube at —50° C. and inspected at intervals for the appearance of gray Sn. In each test, samples of pure Sn, subjected to the same thermal and mechanical treatment as the alloy, were used for comparison. Of all investigated Sn alloys, only that with 0.01 wt. % Mg exhibited acute Sn plague in conjunction with the Heyn-Wetzel phenomenon described in the author's previous paper. The retarding effect of minute contents of Bi on the white Sn → gray Sn transformation has been satisfactorily explained by Mason & Forgeng (*Metals and Alloys*, Vol. 6, 1935, pp. 87-90), whose paper is reported in detail. ORS (9b)

The Martensite Transformation in Beta Copper-aluminum Alloys. ALDEN B. GRENINGER (Harvard Univ.) *Metals Tech.*, Vol. 6, Feb. 1939, T.P. 1039, 18 pp. Original research. An X-ray and microscopic study of the martensite transformation in β Cu-Al alloys containing from 9.3 to 15.35% Al was made. The following orientation relationships were accurately determined for both β' and γ' martensite: (1) The relationship between the martensite lattice and the matrix β lattice; (2) the orientation of the martensite lattice in relation to the plane of the martensite plate; and (3) the orientation of the martensite plate in relation to the matrix β lattice. An alloy of 9.3% Al rapidly quenched from the β range undergoes mass transformation to α. If the alloy is quenched even more rapidly, the resulting structure is similar to β' except that the atom arrangement is disordered instead of ordered. As the Al content is increased to about 14%, the hexagonal close-packed lattice of γ' becomes slightly distorted. This distortion is likened to the change from cubic to tetragonal martensite in steel as the C increases. The striations in γ' martensite are shown by X-ray studies to be due to polysynthetic twinning on (10.1). 20 references. JLG (9b)

Effect of Silver on the Gold-copper Superlattice, AuCu. RALPH HULTGREN & LESTER TARNOPOL (Harvard Univ.) *Metals Tech.*, Vol. 6, Jan. 1939, T.P. No. 1010, 10 pp. Theoretical and research. It is postulated that the chief causes of superlattices are attraction between unlike atoms and differences in atomic size; the simultaneous action of these factors is considered. Superlattices are composed of atoms differing considerably in size or electrochemical potential. Ferromagnetism may be an additional factor. Thermodynamic reasoning indicates that Ag substituted for Au in AuCu should lower the critical temperature of ordering. Experiments verified this prediction. The orthorhombic, pseudotetragonal phase discovered by Johansson and Linde was found to be stable over a wider range of temperature than they had supposed. At lower temperatures, the well-known tetragonal cell is found. The pseudotetragonal cell of the orthorhombic phase has a b/a ratio very slightly greater than one. As the temperature of anneal decreases towards the region of stability of the tetragonal phase, the b/a ratio increases. At room temperature the b/a ratio increases with time. JLG (9b)

Roentgenographic Methods in the Investigation of Aluminum Alloys (Röntgenographische Methoden bei der Untersuchung von Aluminium-Legierungen) W. HOFMANN. *Aluminium*, Vol. 20, Dec. 1938, pp. 865-872. Practical. The convenience and importance of the Debye-Scherrer method for the metallographic examination of alloys as supplement to other physical methods is explained and illustrated by examples. The determination by the reflection method of the α-corner of the eutectic 4-phase plane in the Al-Fe-Mg system and the examination of supersaturated solid solutions of Mn in Al is described. Four intermediary crystal types are established in the system Al-Mn. Al_6Mn, orthorhombic, a = 6.51 A. U., b = 7.57, c = 8.87; x_1 monoclinic or triclinic, a = 5.1 A. U., b = 5.1; angle between a and b = 101.5°; y_1, orthorhombic, a = 14.79 A. U., b = 12.60, c = 12.43. 19 references. Ha (9b)

10 Properties and Applications

Including Relation of Properties to Engineering or Product Design. See also Sections 8a and 11.

M. GENSAMER, SECTION EDITOR

Quantity Production of Metal Aircraft Is Possible. G. H. CLARKSTON. *Sheet Metal Ind.*, Vol. 13, Feb. 1939, pp. 246-248; Mar. 1939, pp. 399-400. Survey. Specific strength (strength divided by specific gravity) is of greatest importance in airplane construction. Values given are as follows:

	Ult. T. S. lb./in.² / Specific Gravity
High tensile steel	23,100
Duralumin	21,000
Elektron	22,000
Spruce wood	20,000
Synthetic wood	21,000
Reinforced Bakelite	20,600

In the materials that come into consideration, there is not much choice on the basis of specific strength. Wood does not allow mass production, although synthetic wood may if it does not warp. The automotive industry has shown that mass production with metals is possible. Duralumin is the easiest of the metals to work, although it must be annealed for extensive cold work. Elektron is similar to Duralumin in regard to working properties. From the standpoint of national economy, Elektron is preferable, since an adequate supply could probably be produced in England. JZB (10)

Some Metallurgical Developments in Automotive Construction (Quelques Noveautés Métallurgiques en Construction Automobile) R. CAZAUD. *Tech. Moderne*, Vol. 30, Nov. 1, 1938, pp. 719-724. Survey of materials used in France. *Cylinder blocks:* Alloy cast iron of 3.2% total C, 2% Si, 0.8% Mn, 1.6% Ni, 0.5% Cr—220-250 Brinell. *Cylinder liners:* Alloy iron of 3.3% total C, 2% Si, 2.7% Ni, 0.9% Mn, 0.7% Cr—machinable at 240-300 Brinell. This is used both un-heat treated, and at 400-500 Brinell (oil or air quench from 850° C., and tempered at 300° C.). Ni-resist is also used; it has lower hardness and higher wear resistance than the lower alloy cast iron. Aubert and Duval use a nitrided, centrifugally cast material with 2.6% total C, 2.5% Si, 0.6% Mn, 1.7% Cr, 1.45% Al. After oil quenching from 850° C. and tempering at 650° C. to give a core hardness of 300-350 Brinell, it is nitrided for 80 hrs. at 510° C.; especially good results have been obtained with this on Diesel engines. *Pistons:* Alpax with 13% Si, remainder mainly Al; 18% Si-Al alloy is used for special purposes. This differs from the Loex piston used in England, which contains 14% Si, 0.9% Cr, 2% Ni, 1% Mg, remainder Al, and has a Brinell of 125-140 after water quenching from 515° C. and tempering at 180° C. The Al alloy most used has 2.2% Cu, 1.3% Ni, 1.5% Mg, 1.2% Fe, 1.25% Si, 0.1% Ti, and a Brinell hardness of 125-150 after water quenching from 530° C. and tempering at 180° C. Anodic treatment is commonly used to reduce wear. *Piston rings:* Alloy iron of 3.5% C, 2.7% Si, 0.7% Mn, 2.2% Ni. *Crankshafts:* Ford's high C-Cu cast steel, also nitrided Ni-Cr, Ni-Cr-Mo, and Cr-Mo steels. *Camshafts:* Alloy iron casting containing 3% C, 1.9% Si, 1% Ni, 0.2% Cr, 0.3% Mo. *Bearings:* Large variety of Cu, Cd and Zn alloys are used. Cd with 2.2% Ag and 0.2% Cu or 1.35% Ni looks promising when In-plated to prevent corrosion. Zn-Al is used in Italy, and Zn with 8% Cu and 0.4% Al in Germany. JZB (10)

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The Nature of Sliding and the Analysis of Friction. F. P. BOWDEN & L. LEBEN. *Proc. Royal Soc., London, A,* Vol. 169, Feb. 1939, pp. 371-391. Original research. A careful study was made of the changes of frictional force that occurred while a smooth metal surface was moved uniformly and steadily beneath a smaller upper surface fixed to a friction-measuring device. Simultaneously, measurements of the surface temperature were made, using the 2 sliding metals as the elements of a thermocouple. When the small slider and lower plate are clean, polished and unlubricated, sliding is found to proceed in a series of jerks. The surfaces stick, move together for a brief period, and suddenly slip. Friction is apparently due to actual welding at the points of contact, for every time a slip occurs there is a very sudden rise, followed by a rapid fall, in temperature. The deformations produced extend to a considerable depth below the surface, and thus theories of friction that involve surface forces only must be incomplete. The extent and nature of the slip was found to depend on the relative melting points of the metals. When a metal of high melting point slides on one of low melting point (Mo on steel), the slip is comparatively small and there is a ploughing out of the soft metal. When the slider has a lower melting point than the surface (Ag, Al, Zn, Pb, Sn, or bearing metal on steel), the slip is very much larger in extent, and the heat produced appears to weld the low-melting metal to the other. When both surfaces are of the same metal, however, friction is much higher and fluctuates considerably but with no sudden slips. Both surfaces appear to melt and weld equally. **The Area of Contact Between Stationary and Between Moving Surfaces.** F. P. BOWDEN & D. TABOR. *Ibid.,* pp. 391-413. Measurements were made of the electrical conductivity across contacts of crossed cylinders and flat plates of C, Cu, steel, Sb and Bi pressed together under various loads. With crossed cylinders or spheres on flats, contact occurs uniformly over the deformed area and is reasonably independent of the radius of curvature. With flat surfaces, the real area of contact is not greatly affected by the size, shape or degree of roughness of the surface, but depends mainly on the pressure. The surfaces are evidently held apart by small irregularities, which flow plastically under pressure. With 21 cm.^{2} flats, 1/130 of the area was in contact under a 300 kg. load and only 1/170,000 of the area under 3 kg. When measurements were extended to moving surfaces, the area of contact was found to fluctuate rapidly during sliding. A remarkable correlation was found to exist between these fluctuations and the frictional and temperature changes recorded by Bowden and Leben (previous abstract). Metallic junctions appear to be rapidly formed and broken during this process. JCC (10)

Electric Conductivity of Metals at Very Low Temperatures (La Conductibilité Électrique des Métaux aux Très Basses Températures) M. DÉSIRANT. *Rev. Universelle Mines,* Vol. 15, Feb. 1939, pp. 73-78. Review. The various theories propounded to explain the electric conductivity in metals and supraconductivity at lowest temperatures are discussed. According to most recent investigations (Bridgman, Gruneisen & Gõus), it is assumed that the usually measured resistance is not a fundamental metal constant but depends a great deal on orientation and crystalline condition of the metal; a polycrystalline metal has a higher electric resistance than a monocrystalline metal, *e.g.* the conductivity of polycrystalline Cu is 0.584 x 10^6 ohm^{-1} while that of monocrystalline Cu is 0.662 x 10^6 ohm^{-1}. The application of quantum considerations for the explanation of the behavior of temperature coefficient by the movement of the electron in a field of positive ions is explained and applied for Pt, Cd, Th, Sn and Pb. 37 references. Ha (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

High-duty Cast Irons for General Engineering Purposes. J. G. PEARCE. *Foundry Trade J.,* Vol. 59, Dec. 22, 1938, pp. 459-462; Dec. 29, 1938, pp. 483, 484, 492. Review. General gray Fe castings used for engineering purposes have tensile strength in the 2 grades specified, of 18,000 and 22,000 lbs./in.^{2} on the standard 1.2-in. bar. The demand for an improved material for steam engines yielded cast iron of about 28,000-30,000 lbs./in.^{2} tensile strength, conveniently called "cylinder" iron. The requirements of the heavy-oil engine resulted in the development of cast iron of about 36,000 lbs./in.^{2} tensile strength, termed "Diesel" quality. In 1938, the first national (British) specifications for high-duty cast irons were issued, covering 3 grades: 1, 2 and 3. Grades 1 and 2 correspond approximately with the above-mentioned Cylinder and Diesel qualities. The specification requires minimum tensile and transverse strength in standard bars of sizes varying to suit the cross-section of the castings they represent, the specified strength falling slightly as the size of the bar increases from 0.875 to 2.1 in. in diameter. Use of refined pig-Fe and steel in charges, hot-mold Fe, alloy cast-irons, inoculated irons, melting practice, heat-treatment, malleable cast iron, low-carbon alloy irons, special irons, properties of cast iron, etc., are discussed. A graphitizer such as Si is much more effective when crushed and added to the molten metal than when included in pig-Fe or scrap in the charge. The change produced by such ladle additions to a white Fe is so pronounced that the method is referred to as inoculation. Inoculation enables irons to be made of lower C and Si contents without risk of hardness. Two processes are in regular use in England. "Meehanite" is a low-carbon Fe made from high steel charges, inoculated with calcium silicide, and gives strengths of 40,000-50,000 lbs./in.^{2} in the highest grade. "Ni-Tensyl" is similarly made, but alloyed with Ni and subsequently inoculated with Si, and gives strengths of 44,000-50,000 lbs./in.^{2} Still higher strengths are obtainable from heat treatment or by further alloy additions with both of these materials. Structurally, inoculated irons are fully pearlitic, with relatively fine flake graphite. Special irons may be divided into 3 classes: Austenitic irons, martensitic irons and other special alloy cast irons. Some austenitic irons are registered under a variety of trade names, such as "Nomag" (developed specially as non-magnetic cast iron and containing Ni and Mn), "Ni-resist" (an austenic iron containing Ni, Cu and Cr), and "Nicrosal" (a Ni-Cr-Si iron developed primarily for heat resistance). High-Si cast iron ("Silal") contains 4-10% Si. High-Si cast iron with 13-18% Si is brittle but highly resistant to acids. High-Cr cast iron, containing 20-35% Cr, is used for heat- and corrosion-resisting castings. High-Al cast iron contains about 8% Al and also some Cr. Transverse strength is a standard test for cast iron, giving the breaking load and deflection at fracture. The deflection under transverse loading is used as an index of ductility or toughness instead of elongation in tension. The elastic deflection curve with load approximates a straight line. Plastic deflection or permanent set shows very marked variations from iron to iron. Brittle irons have low set, and tough irons a high set. Such irons show a marked difference in shock strength. The value for the elastic modulus of gray iron (calculated from the elastic deflection) varies from 9 x 10^6 to 20 x 10^6 lbs./in.^{2}, but for special irons, values of 30 x 10^6 lbs./in.^{2} have been reached. Malleable cast iron has a definite yield, and the modulus is 23 x 10^6 to 25 x 10^6 lbs./in.^{2} White cast irons as a rule give erratic test figures because of their brittleness, but frequently give strength figures exceeding those of the same iron in the gray state. The elastic modulus of white irons may reach 25 x 10^6 to 27 x 10^6 lbs./in.^{2} AIK (10a)

Wear Resistance of Cast Iron and Malleable Iron. W. West & C. C. Hodgson. *Foundry Trade J.*, Vol. 60, Jan. 5, 1939, pp. 3-5. Review plus original research. The survey of ferrous materials for wear resistance covers experience that has been obtained, mainly, in connection with the internal-combustion engine. Present development of cast iron, inoculated irons, super-cooled-graphite iron, P content and porosity, effect of P on resistance to wear under lubricated conditions, and malleable cast iron are discussed. Below 2.5% total C, the physical behavior of cast iron in the liquid state becomes very difficult to control for the production of sound castings. It is particularly in this range, *i.e.* 2.5-1.7% total C, that much of the present development work is being exercised. One practical example of the strength possibilities of this range was obtained from the following composition: T.C., 1.74; Si, 0.62; Mn, 0.63; S, 0.05; Mo, 0.64; and Ni, 1.94%. This material, as cast, showed a fine-grained white fracture, which after annealing and heat-treatment (9 hrs. at 1000° C., cooled to 950° C.; 8 hrs. at 950° C., cooled to 900° C.; 7 hrs. at 900° C.; cooled in air; reheated to 900° C.; transferred to a furnace at 650° C.; held for 1 hr., then cooled in air; re-heat-treated to 850° C., for 1 hr. and cooled in air, tempered at 550° C.) produced an exceptionally fine-grained material, giving a tensile strength of 125,000 lbs./in.^{2} The greatest difficulty arising in the commercial use of such material is the intensive shrinkage that occurs when passing from the liquid to the solid state. Cast iron of low total C content invariably has a pearlitic structure, which gives improved resistance to wear and high mechanical strength. Both properties are desirable for highly-stressed or wear-resisting parts of machinery. By adding a graphitizer, the graphite commences its formation around the inclusion particles (inoculation). The graphitizer may be calcium silicide, ferro-silicon, Al, or a mixture of Ni and ferro-silicon. Calcium silicide is used in making cast iron known as "Meehanite." A high grade of Fe can be obtained with tensile strength up to 23 tons per sq. in. for unalloyed iron. A mixture of Ni and ferrosilicon is employed in production of cast iron sold under the name of "Ni-Tensyl." The addition is made, as usual, to the molten metal as it runs from the spout of the cupola. It is now generally recognized that for intricate castings it is much better to have the P content not over 0.3% if soundness in the sections is required. The great disadvantage in using low P irons is that their resistance to wear is considerably less than that of the higher P cast irons. There are 2 varieties of ordinary malleable cast iron, namely, white-heart and black-heart. Of these, one would consider only the former as a characteristically wear-resistant material. Well-made white-heart iron consisting essentially of graphite and laminated pearlite, is a material that gives good results when used for such parts as lightly loaded gears, and other parts where the stresses and pressures are not high. By suitable heat treatment of black heart malleable iron, it is possible to combine the advantages of rapid machining obtained from normal black heart with the good wear resistance of white heart. The heat treatment consists merely of heating the parts up to a suitable temperature, generally, between 850° and 900° C., and after soaking, allowing them to cool in air. This treatment causes some of the graphite to pass into solution, and the relatively quick cooling causes the C so dissolved to form pearlite. Still closer to the steel range is a group of alloys, the members of which are best regarded as high-Si cast steels containing graphite, or as alloy malleable cast irons. Many of these materials possess excellent wear-resisting surfaces. The success obtained by the Ford Co. with their cast crankshafts, using a high-C alloy containing Cu and Cr, is well known. The presence of the graphite no doubt has something to do with the satisfactory wear resistance obtained. Graphite steels have met with considerable success for the manufacture of dies. These steels may be rolled and forged. The authors point out that a graphitic steel was produced and sold by at least one Sheffield steel company about 30 yrs. ago. AIK (10a)

Magnetic Transformation and Catalytic Activity. VI. Catalytic Experiments with $MgO.Fe_2O_3$ and Different Types of Iron and Steel within the Region of Loss of their Ferromagnetic Properties (Magnetische Umwandlung und katalytische Aktivität. VI. Katalytische Versuche mit $MgO.Fe_2O_3$ und verschiedenen Eisen- und Stahlsorten im Gebiet des Verlustes ihrer ferromagnetischen Eigenschaften) Arvid Hedvall & A. Berg. *Z. physik. Chem.*, Abt. B, Vol. 41, Nov. 1938, pp. 388-395. Original research. Continuing the series of their investigations on the effect of the magnetic transformation on the catalytic activity of various catalyzers, the authors passed a current of CO and H_2 mixed in the proportion $1 \div 3$ over finely powdered pig Fe with 4.26% C, 0.98% Si, 1.61% Mn, 0.023% P, 0.029% S, or over turnings of an alloy steel with 0.43% C, 1.00% Si, 0.26% Mn, 0.026% P, 0.017% S, 1.08% Cr, 0.10% V, 1.90% W, at various temperatures and quantitatively determined the products of the gas reaction. The Curie interval of the pig Fe extended from 710° to 737° C., that of the alloy steel from 700° to 740° C., as determined by the method described in the previous papers, care being taken to prevent oxidation of the samples. With both catalyzers, the reaction was found to proceed predominantly according to the formula $CO + H_2 = C + H_2O$ at temperatures below the Curie interval, and predominantly according to the formula $CO + 3H_2 = CH_4 + H_2O$ at temperatures above the Curie interval, CH_4 being present in the reaction product only in the latter case. The shift is more pronounced in the case of pig Fe. These findings furnish another example of the selective difference between the magnetic and non-magnetic condition of ferromagnetic catalyzers. ORS (10a)

Cast Iron in Engineering Construction. J. L. Francis. *Iron Steel Ind.*, Vol. 11, Sept. 1938, pp. 607-613; Vol. 12, Oct. 1938, pp. 17-22; Nov. 1938, pp. 181-184; Dec. 1938, pp. 207-209. Survey. The presence of graphite imparts an effect of internal notches, and reduces the influence of additional external notches. The finer grained and lower graphite cast irons are more notch sensitive, and polishing high grade and high alloy cast iron greatly raises the endurance limit. Much attention is given to growth of cast iron. Alternate heating and cooling accelerates growth and may even be necessary for its initiation, because the expansion and contraction set up augments the entry of gases. Growth begins at 650° C. and progresses with maximum rapidity at 730° C. One analysis of a growth resisting Fe is given as 4.5-6% Si, with a ferritic, fine-grained structure, no combined C, and total C under 3%. Faulty lubrication, as found by the brake shoe test, is more detrimental to ferritic (low combined C) cast iron than to pearlitic. Presence of a phosphide eutectic is extremely deleterious, as particles wear away to form a hard abrasive. The British hold that graphite in cast iron does not act as a lubricant but that the better wear of soft Fe is due to the formation of a glaze on the surface, whereas in hard irons, spiky crystals of Fe_3C break off and form an abrasive paste. In the blunt-drill test, wear is a minimum when the stationary and moving blocks are of equal hardness. Influence of composition and effect of surface finish, especially on parts used for pistons and cylinders, are discussed as well as some considerations of chemical wear and corrosion. Stainless irons and steels of 14-30% Cr are among the best materials for resisting attack of HNO_3 of any concentration. High Ni austenitic iron is very resistant to caustic alkalis. Corrosion resistance of ordinary cast iron is improved by the degasification, graphite and grain refining action of soda ash treatment. It also tends to refine pearlite structure. Castings made by this method show very even chemical corrosion and wearing and greatly reduced pitting. Amount of non-metallic inclusions and size and disposition of graphite flakes greatly affect degree and nature of corrosion by steam or cavitation. 20 lbs. of soda ash per ton of metal treated is recommended and no interference with routine melting practice is necessary. HFT (10a)

Relations between Structure and Tensile Strength of Gray Cast Iron (Beziehungen zwischen Gefüge und Zugfestigkeit des grauen Gusseisens) H. Hanemann & A. Schrader. *Arch. Eisenhüttenw.*, Vol. 12, Nov. 1938, pp. 253-256. Original research. Examination of the structure of gray cast Fe leads to the conclusion that the tensile strength increases with decrease of the saturation value $S = \% C/(4.23 - \% Si/3.2)$. The saturation value can also be expressed as the ratio of total C to eutectic C; that is, the more primary graphite the lower the tensile strength. This was confirmed by a series of tests on 25 gray cast irons containing 3-3.8% C, 1-3% Si, 0.4-1.1% Mn, 0.1-1.0% P, and 0.03-0.13% S. Finely divided graphite, arranged in separate flakes rather than grouped in nests, tended to give the highest strength. SE (10a)

Significance and Causes of Internal Wire Fractures in Wire Ropes, Especially Hoisting Ropes (Bedeutung und Ursachen innerer Drahtbrüche bei Draht-, im besonderen Förderseilen) H. Herbst. *Glückauf*, Vol. 74, Oct. 8, 1938, pp. 849-856; Oct. 15, 1938, pp. 878-884. Research. Methods to detect wire fracture during service life of wire ropes are discussed at length and experiments made to discover the causes more directly. In most cases, a wire fracture can be detected by the eye, or if necessary, by an electromagnetic examination. The causes are usually excessive bending stresses due to pressure in the grooves of the drums or to mutual pressure of the strands. Correct manufacture of ropes and proper treatment during operation will do much to prevent fractures. Ha (10a)

Low-temperature Transformation in Iron-nickel-cobalt Alloys. L. L. Wyman (Gen. Elec. Co.) *Metals Tech.*, Vol. 6, Jan. 1939, T.P. No. 1013, 14 pp. Original research. High-purity Fe-Ni-Co alloys were prepared and their thermal expansion coefficients determined. Alloys contained from 26.5 to 34% Ni, from 10 to 20.5% Co and from 53 to 56% Fe. It was not found possible to predict the expansion coefficients by formulas. Low-temperature transformations occur over a wide range of temperature because of lack of equilibrium conditions and are influenced by time, temperature, stress and grain size. Micrographs of several of the alloys are shown. The $\alpha \rightarrow \gamma$ transformation occurs at or below 450° C. JLG (10a)

Ferromagnetic Transformations (Ferromagnetische Umwandlungen) WALTER GERLACH. *Z. Electrochem.*, Vol. 45, Feb. 1939, pp. 151-166. Authoritative review. The crystallites of ferromagnetic bodies are completely saturated at low temperatures (internal or spontaneous magnetization). Since the crystal axes are distributed at random, a piece of Fe appears outwardly non-magnetic. By means of an exterior field, the momentums are rectified (coaxial) and poles are formed. If all elementary magnets are rectified, the condition is called "saturated." Abnormal behavior in almost all physical characteristics is concomitant with internal magnetization, independent of external magnetization. The amount of internal magnetization varies with temperature; it decreases first slowly and later rapidly, with increasing temperature. The range within which this transition from ferro-magnetic to normal metallic state occurs is called the Curie-temperature. (1) The ferromagnetic transformation does not show a temperature hysteresis. (2) Neither plastic nor elastic deformation has an influence on it. (3) The magnetization-field curve shows a smooth transition. (4) With rising temperature a slow, later on rapid, increase of the specific heat is observed, a distinct maximum is reached; thereafter C_p drops rapidly, then slowly reaching a constant value. Part of the heat energy is used to destroy the magnetic energy. (5) The temperature coefficient of the electrical resistance rises to a distinct maximum; above the Curie temperature, it drops rapidly, then slowly reaches the "normal" value. (6) The temperature coefficient of the thermionic emission has a maximum at the same point as 5. (7) The thermoelectric force and Thomson-coefficient show an abnormality corresponding in all details to 5. (8) The heat convection shows maximum at the Curie-temperature. (9) Elastic constants are changed by the magnetic transformation because the magnetic momentums (direction of spontaneous magnetization) are distorted from their natural position. In the range of the Curie-temperature, the moment of elasticity shows abnormality. If the metal is subjected to a field strong enough to hold the momentums in the same direction, the abnormality disappears (one exception exists). (10) Abnormality seems to exist for the thermal expansion in the range of magnetic transformation. (11) The carrier of the magnetic momentum is the electron, the momentum being the "spin." 60 spin momentums exist for a lattice of 100 Ni atoms. The value for the momentum is greater above the Curie-temperature. The reason is not known. (12) Saturation-magnetization and, therefore, spontaneous magnetization are independent of an elastic stress. (13) Change of the Curie-temperature with pressure has been found. (14) The magnetostriction based on the direction of the momentum decreases with temperature, does not stop at the Curie-temperature but drops asymptotically to 0. (15) Change in chemical reaction rate in the Curie-temperature range was found. (16) Magnetic transformation occurs in 2 steps: the first in a very narrow temperature range, the other over a range of at least 50° C. RPS (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Progress of Magnesium Alloys in the United States. *Light Metals*, Vol. 2, Feb. 1939, pp. 54-57. Review. The use of Mg alloys in the U. S. has been mostly restricted to "producers" rather than consumers. Its use in the aircraft industry is, of course, well known. Undoubtedly in the future there will be more consumer interest in Mg alloys as the result of consumer education. One outstanding consumer product utilizing the light weight of Mg is the Hoover vacuum cleaner. The Dow Chemical Co. has built an experimental bus body entirely of ultra light alloys; 80% consisted of Dowmetal. The improvement in physical properties and the levelling of price differences between Al and Mg alloys has promoted increased use of Mg alloys in machine tool construction. A notable use has been made in an automatic packaging machine, where the use of the very light weight Mg alloys has reduced inertia in reciprocating parts, and has enabled an increase in speed without provoking undue vibration. New and durable "art-finishes" have been a featured development in recent years, with promise of more on the way. The rather drab appearance of untreated Mg alloy surfaces necessitates the use of paint, lacquer or anodized coating for consumer appeal as well as for corrosion resistance. It is difficult to predict the ultimate relative positions of Al and Mg alloys, as the rate of progress is so rapid. While the physical and chemical properties of the 2 types of light weight alloys are rather different, and in a sense non-competitive, yet obviously in certain applications they do compete. While the technology of Al alloys is much the older of the 2, they have not yet finished their expansion into new fields. On the other hand, it has been said that Mg alloys stand where Al alloys stood about 40 years ago. While this statement, of course, cannot be taken too literally, it is indicative of the expansion that may be expected in this field. AUS (10b)

Magnesium Alloy Sheet. *Light Metals*, Vol. 2, Feb. 1939, pp. 42-45. Review. Manufacturers of equipment in which weight saving is an important factor are now realizing the advantages of Mg alloys. The aircraft industry is naturally much interested in Mg alloys, and is a large consumer of them. The newer Mg alloys, containing about 1.6% Mn or over, with very low Fe contents, and finished with the chromate process, are highly corrosion resistant. Their notch-sensitivity may be diminished by proper attention to fabricating methods; in general, welding is recommended as against riveting. Care must be taken to insulate Mg alloys from contact with other metals in a fabricated structure, as this is a common source of corrosion. Mg alloy sheet is extensively used in monocoque fuselages where its lightness, corrosion resistance, ease of working and weldability make it an ideal material for construction. The Mueller combination press and drop hammer has been found to be very useful in forming Mg alloy sheet. This press has been extensively used for making panels, doors, fuselages, cowling, ribs, etc., from Elektron sheet. Cast Elektron dies are coming into use to replace the usual Zn, Pb or steel dies. The sheet material flows very readily over the Mg alloy surface. In certain countries Elektron is the standard material of construction for oil tanks, and, with a suitable inhibitor, has been found to give good service in gasoline tanks. AUS (10b)

The Hot Hardness of Aluminum Alloys, with Special Reference to Bearing Metals (Ueber die Warmhärte von Aluminiumlegierungen, mit besonderer Berücksichtigung der Aluminium-Lagermetalle) M. v. SCHWARZ. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde*, 1938, pp. 71-74; with discussion. Research. The Brinell hardness (30 secs. or 2 min. loading time) of commercial Al alloys was determined at 20°, 50°, 100° and 250° C.; the heating time was 30 min. The heating time has a large effect on the hardness, especially in the 100°-200° C. temperature range, because of precipitation hardening. Since the hot hardness depends considerably on the testing conditions, the working procedure should be standardized. It is notable that with certain "self-hardening" cast Al bearing metals (containing 2% Cu, 0.4% Si, 0.5% Mn, 0.4% Fe and 0.15% Ni, or 5% Cu, 0.4% Si, 0.5% Mn, 0.4% Fe and 0.5% Ni) the hardness was found almost independent of the temperature up to 150° C.; this should favorably affect their running properties. GN (10b)

The Thermal and Electrical Conductivity of Cast Aluminum Alloys with Especial Attention to Self-aging Alloys (Die thermische und elektrische Leitfähigkeit von Aluminium-Gusslegierungen unter besonderer Berücksichtigung selbstveredelnder Legierungen) MAX ELFLEIN. *Forschungsarb. Metallkunde Röntgenmetallog.*, No. 23, 1937, 63 pp. Original research. Commercial and experimental cast Al alloys were investigated. Rockwell hardness, density, thermal and electrical conductivity were determined before and after aging at room temperature. Some of the alloys had relatively high hardness combined with good thermal conductivity, and were therefore applicable for pistons for internal-combustion engines. There was a rather wide variation in the Lorenz coefficient. JLG (10b)

The Effect of a Magnetic Field upon the Electrical Resistance of Gold and Silver at Temperatures between 1 and 20° K. J. W. STOUT & R. E. BARIEAU (Univ. Cal.) *J. Am. Chem. Soc.*, Vol. 61, Feb. 1939, pp. 238-241. Original research. For Ag wire at the lowest temperatures, both the resistance and the magnetic coefficient are independent of temperature. As the temperature rises, the resistance increases and the magnetic coefficient of resistance decreases. The Au wire has a minimum of resistance at about 7.7° K., while the magnetic coefficient is maximum. Extrapolation of the measurements indicates that below 1° K. the magnetic coefficient would be negative. MEH (10b)

The Dependence of the Specific Resistance of Platinum on the Diameter of the Wire (Zur Abhängigkeit des spezifischen Widerstandes von Platin vom Drahtdurchmesser) L. RIEDEL. *Ann. Physik*, Vol. 33, Dec. 1938, pp. 733-736. Research. Previous results of H. Reuter, according to which the specific resistance of Pt wires increases considerably with decreasing wire diameter, could not be corroborated in recent more exact examinations; an increase of little more than 1% could be found. This shows that in Pt (at 0° C.), the mean free path of the conduction electrons is of the same order as in other normal metals, *i.e.* 10-100 millimicrons. Ha (10b)

The Diffusion of Magnesium in Aluminum (Ueber die Diffusion von Magnesium in Aluminium) W. BUNGARDT & F. BOLLENRATH. *Z. Metallkunde*, Vol. 30, Nov. 1938, pp. 377-383. Experimental. A core of an Al-Mg alloy was fitted carefully into an Al cylinder. Diffusion coefficients were determined by machining off layers and analyzing for Mg. Values were obtained over a temperature range of 400° to 550° C. In pure Al, $D = 6.6 \times 10^{-6}$ cm.^{2}/day at 420° C. and 4.5×10^{-4} at 520° C. The corresponding values for the diffusion of Mg in an Al alloy containing 2.7% Zn are 3.6×10^{-6} and 1.9×10^{-4}. The D values are increasingly dependent upon Mg concentration at higher temperatures. GD (10b)

The Influence of Small Amounts of Iron, Lead and Tin on the Mechanical Properties and Drawability of a 67/33 Brass (Ueber den Einfluss kleiner Mengen von Eisen, Blei und Zinn auf einige mechanische Eigenschaften und die Tiefziehfähigkeit des Ms 67/33) W. LOSKIEWICZ, W. KURSZEC & J. SZYSZKA. *Metallwirtschaft,* Vol. 18, Feb. 10, 1939, pp. 119-122. Research. Brasses containing from 0.02 to 0.77% Fe, 0.04 to 0.80% Sn and 0.041 to 0.68% Pb as well as Fe and Sn in total amounts from 0.04 to 1.53%, Fe and Pb in amounts from 0.21 to 1.55, Pb and Sn in total amounts from 0.22 to 1.47% and Fe, Pb and Sn in amounts from 0.142 to 2.89% were studied. Fe up to 0.77% does not affect hot or cold rollability. Increasing Fe decreases grain growth at high annealing temperatures. Fe increases tensile strength and hardness while decreasing elongation. Brasses containing over 0.02% Pb or 0.18% Sn cannot be hot rolled successfully and in these experiments had to be cold rolled. The mechanical properties are influenced only slightly by Pb or Sn. When several of these impurities are present, the hot rollability is governed by the Pb or Sn content, while the mechanical properties are mostly a function of the Fe content. Small additions of Fe, though decreasing elongation, do not decrease the drawability as determined by cup testing. Small amounts of Pb and Sn (under 0.4%) do not affect the drawing characteristics of the brass. The resistance to stress corrosion of brasses in a solution of 0.5% $HgNO_3$ + 0.5% HNO_3 is increased by the addition of Pb and decreased by Sn and Fe. The presence of other impurities, such as Bi and Sb, will seriously alter the results obtained in the above experiments.
GA (10b)

The Structural Characteristics of Certain Silver Films. S. F. ESSIG (Thwing-Albert Instrument Co.) *J. Applied Phys.,* Vol. 10, Jan. 1939, pp. 61-72. Experimental research. Three types of very thin Ag films of the kind used in television image analyzers are treated. These films are prepared either by (a) thermal reduction of Ag oxide dust, or (b) by evaporation or sputtering followed by an agglomeration heat treatment. In method (a) there is a wide range of resulting particle size ($<$ 1 to 30 μ). Powders reduced at temperatures above 600° C. give films decidedly different from those obtained by reduction below 600°. This is considered due to a distinct liquid phase in the Ag-silver oxide system. Films produced by method (b) have smaller and more uniform particle sizes, and both particle size and spacing is readily controlled and reproducible. The character of the mosaic or Ag lacework is determined by the initial film thickness mainly, but temperature, time of heating, and the nature of the substrata (mica, glass, quartz, etc.) also play a part. The range of initial thicknesses studied was 0.01-0.20 microns. Translucent, composite films were also studied. These consisted of a Ag mosaic superposed on a thin, electrically conducting, Pt film of high light transmission. It was found necessary to place a thin protective coating of alumina or silica on the Pt before placing the Ag film to prevent destruction of the conducting film by oxidation or by alloying with the Ag film. The technique and apparatus used are described.
HFK (10b)

Study of the Nature and Properties of Copper-beryllium-nickel Alloys. M. P. SLAVINSKII, N. A. FILIN & L. P. RYBAL'-CHENKO. *Metallurg,* Vol. 13, Nov. 1938, pp. 7-16. In Russian. Research. The Cu-Be-Ni alloys were prepared from electrolytic Cu and Ni, and from Cu-Be and Ni-Be alloys containing 12.56% and 11.73% Be, respectively. The effect of Ni additions upon the phase diagram of Cu-Be alloys was investigated by thermal analysis. Four sections, containing 0.6, 0.8, 1.2, 2, and 3% Be and 0.5, 1, 2, and 3% Ni, were studied. The addition of Ni up to 3% contracts the limits of the solid solution by 0.5-0.6% at room temperature and by 1% at 860° C. An increase of Be raises the hardness and reaches a maximum of 200 Brinell units for 3% Be. The effect of Ni is the same, except that for the alloy with 3% Be the addition of Ni decreases the hardness by 33 units. The alloys were subjected to artificial aging; the maximum aging effect was reached after 7 hrs. at 350° C. The addition of Ni decreases the aging effect. Alloys with 2-3% Be had the maximum aging effect. Metallographic investigations of cast, hardened and annealed alloys agreed with the results of thermal analysis.
BZK (10b)

The Aircraft Propeller. The Factors of Its Evolution (L'Hélice Aérienne. Les Facteurs de son Évolution Actuelle) P. DE VALROGER. *Tech. Moderne,* Vol. 30, Nov. 15, 1938, pp. 788-794. Review. The most common alloys used in France are duralumin, RR 56, and alferium, all high-strength Al alloys with fatigue strengths around 17,000 lbs./in.^{2} Hollow steel blades have been tried, but it has been difficult to make a joint with the proper fatigue strength. Also, experimental work has been done on light woods covered with a sheathing or impregnated with synthetic resin. Blades of Mg alloys, such as Elektron, are promising for use on special high speed airplanes. Their use on Hispano has lowered propeller weight from 140 to 116 kg.
JZB (10b)

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Production, Properties and Fields of Application of Electrolytically Purified Aluminum (Gewinnung, Eigenschaften und Verwendungsgebiete des elektrolytisch geläuterten Aluminiums) H. RÖHRIG. *Z. Ver. deut. Ing.,* Vol. 83, Jan. 7, 1939, pp. 33-39. Review. The development of processes for purifying commercially produced Al of about 99.5% is described; at present, most Al of more than 99.99% is produced in the 3-layer bath with anodes of an Al-Cu alloy, in an electrolyte of 23% AlF_3, 17% NaF and 60% $BaCl_2$, at 750° C. The various modifications of this process are discussed. The tensile strength of 99.996% Al decreases practically linearly from 28,000 lbs./in.^{2} at 100° C. to 0 at about 580° C.; it melts at 660.2° C., specific gravity is 2.6989 at 20° C., the electric resistance is 0.026548 ohm mm.^{2}/m. at 20° C. and the linear expansion coefficient 23.86 x 10^{-6} from 20° to 100° C. The natural oxide film on it is very uniform, and highly polished Al has a reflectivity of 90% and does not tarnish. Its chemical resistance, even to HCl, is very high. Such Al is used for mechanical plating, for cable sheaths instead of Pb, foils for packing material, and electric condensers, in which application the low dielectric loss is utilized. 31 references.
Ha (10b)

Types of Creep Curve Obtained with Lead and Its Dilute Alloys. J. NEILL GREENWOOD & HOWARD K. WORNER. *J. Inst. Metals,* Vol. 64, 1939, Advance copy No. 829, 24 pp. Original research. Four distinct types of creep curve are obtained with Pb and its dilute alloys under stresses of 350 and 500 lbs./in.^{2} Type A shows strain hardening, and after a certain stage there is a marked increase in creep rate owing to recrystallization. Type B shows initially an increase in creep rate and then strain hardening, but no recrystallization. This type is accompanied by intercrystalline failure. Type C shows a continuously increasing creep rate, which is believed to be associated with loss of cold-work hardness during the test and also with an increase in the proportional limit as compared with the basis Pb. Type D is a normal strain-hardening variety, characteristic of metals that are below the recrystallization range of temperature. Curves are given to illustrate the effects of stress and composition, initial cold working and grain size. In a theoretical section it is suggested that creep has 2 components: (a) Viscous flow, and (b) plastic flow. In the range of lower stresses and with cold-worked material, viscous flow is considered to be the more important. The proportional limit is suggested as an approximate point of division between high and low stresses for this purpose. The types of curves mentioned are considered in light of this theory.
JLG (10b)

Recent Investigations of Lead and Lead Alloys (Neue Forschungen über Blei und Bleilegierungen) W. HOFMANN. *Z. Ver. deut. Ing.*, Vol. 83, Feb. 4, 1939, pp. 117-122. Review. Pb is a particularly interesting metal because many phenomena that in other metals take place only at elevated temperatures, can be observed in Pb at ordinary temperature. Pb-Sb is a precipitation-hardening alloy; the greatest hardness is obtained with 0.5-3.0% Sb. Cu and As additions of only a few 1/100% improve precipitation-hardening considerably. Pb-Ca alloys show the same property, the most favorable Ca content being 0.035%. The hardness of the latter alloy can be further increased by additions of Na and Li. Pb-Sn and Pb-Cd show much less precipitation-hardening. Pb-Ca alloys have a very much delayed recrystallization after cold-working; the same is also the case in Pb-Te alloys. A Pb alloy with high fatigue strength (for cables and installations on shipboard) consists of 1-3% Sn, 0.6-1.0% Sb, 0.05% Te. Some fatigue strengths are given below:

Alloy	Fatigue Strength	Brinell Hardness
Pb 99.99%	450 lbs./in.^{2}	2
Pb with 1.2% Sn, 0.2% Cd, 0.1% Sb	1,000 lbs./in.^{2}	5
Pb with 0.07% Ca	1,400 lbs./in.^{2}	8.4
Pb with 1% Sb, 0.05% As (hard lead A)	1,800 lbs./in.^{2}	10.8

Practically no corrosion takes place in Pb in drinking water; distilled water, especially with access of air, attacks very slightly; here Ca-Pb alloys behave most favorably. Cold 80% H_2SO_4 had the same effect as drinking water, but hot H_2SO_4 disintegrated Pb alloys with Cd, Ca, Bi, As, Zn, Sn, Sb, and Se, while Ni, Ag, Cu and Te alloys of Pb resisted, with formation of a layer of $PbSO_4$. 28 references. Ha (10b)

Mold Castings of Zn Alloys (Formguss aus Zinklegierung) F. N. HUTH. *Giessereipraxis*, Vol. 60, Feb. 26, 1939, pp. 90-94. Descriptive. Physical, mechanical, chemical and casting properties of an Al-bearing Zn alloy containing 3.8-4.0% Al, 1.1-1.3% Cu, 0.02-0.04% Mg, remainder Zn, and of a solderable Zn alloy of absolute dimension stability containing 0.2-0.25% Al, 3.6-4.5% Cu, remainder Zn, are given. The first alloy is highly sensitive towards impurities, a few hundreds of a per cent of Pb, Sn and Cd causing intercrystalline corrosion. Pb with or without Sn + Cd should not exceed 0.008%. Application of these alloys to water fittings, valves, water meters, etc., are discussed. After 3 years of trial, these alloys proved suitable to replace corresponding brass parts, and are now finding increasing application. GN (10b)

Platinized Nickel-chromium and Nickel-chromium/Palladium Catalysts. I. Method of Preparation and Field of Applications. M. S. GERSHENOVICH & N. Z. KOTELKOV. *Zhur. priklad. khim.*, Vol. 11, Feb. 1938, pp. 253-256. In Russian. Original research. Wire, tape or sheet of nickel-chromium alloy oxidized on their surface by heating to 800° C., covered with Kundt's tincture for Pt (or Pd) coating [1 g. Pt chloride (or Pd chloride) dissolved in 3 cc. of alcohol, mixed with 10 cc. of saturated alcoholic solution of boric acid, then mixed with 20 cc. of a 1:1 mixture of turpentine and oil of lavender], dried, and subsequently annealed at 800° C., are a full substitute for Pt (or Pd) catalyzers used in oxidation processes in the gas phase. After a single application of the tincture (2 or 3 applications are usually made) the active layer is but 40-60 mμ. thick and consists of metallic Pt (or Pd) in very fine dispersion separated from metallic nickel-chromium alloy by an oxide layer formed on preliminary oxidation of the nickel-chromium specimen and preventing the Pt (or Pd) particles from fusing with the nickel-chromium even at very high temperatures. Furthermore, the Pt (or Pd) particles are so widely spaced on the coarse oxide layer that the chances of their coalescence by recrystallization and consequent coarsening, which would impair the catalytic activity, are very small. These features account for the fact that the catalytic activity of the very minute amount of Pt (or Pd) present in the new type of catalyzer remained unchanged after more than 300 hrs. of operation at temperatures of up to 800° C. During this period the crystal lattice constant of Pt increased from 3.903 A.U. to 3.915-0.002 A.U. and the particle size from 3×10^{-4} to 3×10^{-3} without affecting the activity of the catalyzer in any way. The authors have successfully used this type of catalyzer at temperatures up to 1000° C. and believe that the same principle can be applied to produce substitutes for Pt black, Pt sponge and Pt-coated asbestos. ORS (10b)

The Effect of Composition and Constitution on the Working and on Some Physical Properties of the Tin Bronzes. R. CHADWICK. *J. Inst. Metals*, Vol. 64, 1939, Advance copy No. 827, 16 pp. Original research. The most suitable temperature for the breaking-down of cast structures of a series of bronzes containing up to 30% Sn was determined by forging small cylinders and observing the resulting cracking. Both pure Sn-Cu alloys and a similar series with increasing amounts of P were examined. With the exception of alloys containing from 17 to 19% Sn, all alloys containing up to 25% Sn were rolled into thin strip. The 17 to 19% Sn alloys could not be rolled. Microexamination was first made of the straight Sn-Cu alloys in the form of thin strip quenched from temperatures corresponding to the phase areas in the accepted Sn-Cu diagram. The effect of P additions on the phase changes was then explored. Examination of alloys quenched from 600° C. gave sufficient data on which to base a ternary diagram at this temperature. Curves are given showing the work-hardening of a series of alloys by cold rolling, and tensile properties are given for a number of alloys, in the soft and cold-rolled conditions. JLG (10b)

Lead Bronze Bearings for the Motor Industry (Bleibronzelager für die Motorenindustrie) E. LAY. *Metallwirtschaft*, Vol. 17, Nov. 11, 1938, pp. 1199-1205. Discussion. Pb bronze steel-backed bearings are finding favor in present-day high speed motors. Pb (20-30%)-Cu bearings are used for moderately stressed applications, where the shaft hardness should be about 350 Brinell. A second class of Pb bronze bearings contain additions of Sn, Ni or Mn in amounts up to 2%. These bearings can carry a higher stress, and require a shaft hardness of about 500 Brinell. Additions of more than 2% alloy content to the Pb-Cu base creates a third class of special Pb bronzes that are little used in the motor industry. Bearing play for Pb bronze bearings varies between 1/1000 of the shaft diameter for high speed motors to about 1/1500 of the shaft diameter for average and slow running motors. Pb bronze bearings should not be machined with high speed steel tools, but with hard carbide tools. In machining these bearings, a feed of .05-.08 for Widia tools and .03-.05 for diamond tip tools with cutting speeds of 200-250 m./min. have been found satisfactory. Preparation and examination of the bearings are also covered. GA (10b)

The Significance of Grain Growth in Commercial Silver (Die Bedeutung des Kornwachstums beim Werkstoff Silber) K. W. FRÖLICH. *Chem. Fabrik*, Vol. 12, Jan. 4, 1939, pp. 30-33. Discussion. Many agents, such as molten alkalies or high pressure steam, cause grain growth in Ag. The theoretical conditions necessary for an addition agent to a metal to prevent grain growth are discussed. Practical examples of this type are Ti in Al and Cb in certain steels. Ni performs the same function in Ag. It apparently occurs as very finely divided particles that prevent grain growth. An addition of 0.14% Ni increases the specific gravity of Ag from 10.06 to 10.46. Ni strengthens Ag about 10% at room temperature and 20% at elevated temperature, lowers ductility about 5-10% and doubles the yield point. It does not lower the corrosion resistance of Ag when tested in various acid solutions, and improves it in the case of molten alkalies. PCR (10b)

The Influence of the Iron Content on the Properties of an Aluminum-magnesium-silicon Alloy "Aldrey" (Der Einfluss des Eisengehaltes auf die Eigenschaften von Aluminium-Magnesium-Silizium-Legierungen "Aldrey") M. BOSSHARD & H. HUG. *Metallwirtschaft,* Vol. 18, Jan. 6, 1939, pp. 6-8. Research. The mechanical properties, electrical conductivity and corrosion behavior of the Al-Mg-Si alloy "Aldrey," which is used as a current conductor, were investigated as a function of Fe content. Four Al-base alloys containing 0.43% Mg, 0.57% Si and 0.01, 0.1, 0.2 and 0.3% Fe, were investigated. Drawn wire was tested in the hard drawn condition, and after annealing at 160° C. for 4 or 14 hrs. Of the mechanical properties, only the bend test value seems to be affected by the Fe content. The permissible number of repeated bends is greater for alloys with low Fe content. After subjection to salt water spray, the ductility of the high Fe-containing alloy is sharply decreased. After 6 months in the salt water spray chamber, the following elongation decreases were noted for alloys annealed 14 hrs. at 160° C.: 0.01% Fe—10%, 0.1% Fe—11.5%, 0.2% Fe—36.5% and 0.3%—48%. The decreases for material annealed for only 4 hrs. were somewhat less. At 2 months time, the decreases for the 0.3 and 0.2% Fe alloys were 18 and 24.5%, respectively. Even though atmospheric corrosion is nowhere as severe as the salt water spray, decreasing the Fe content in "Aldrey" wire will increase still further its atmospheric corrosion resistance. GA (10b)

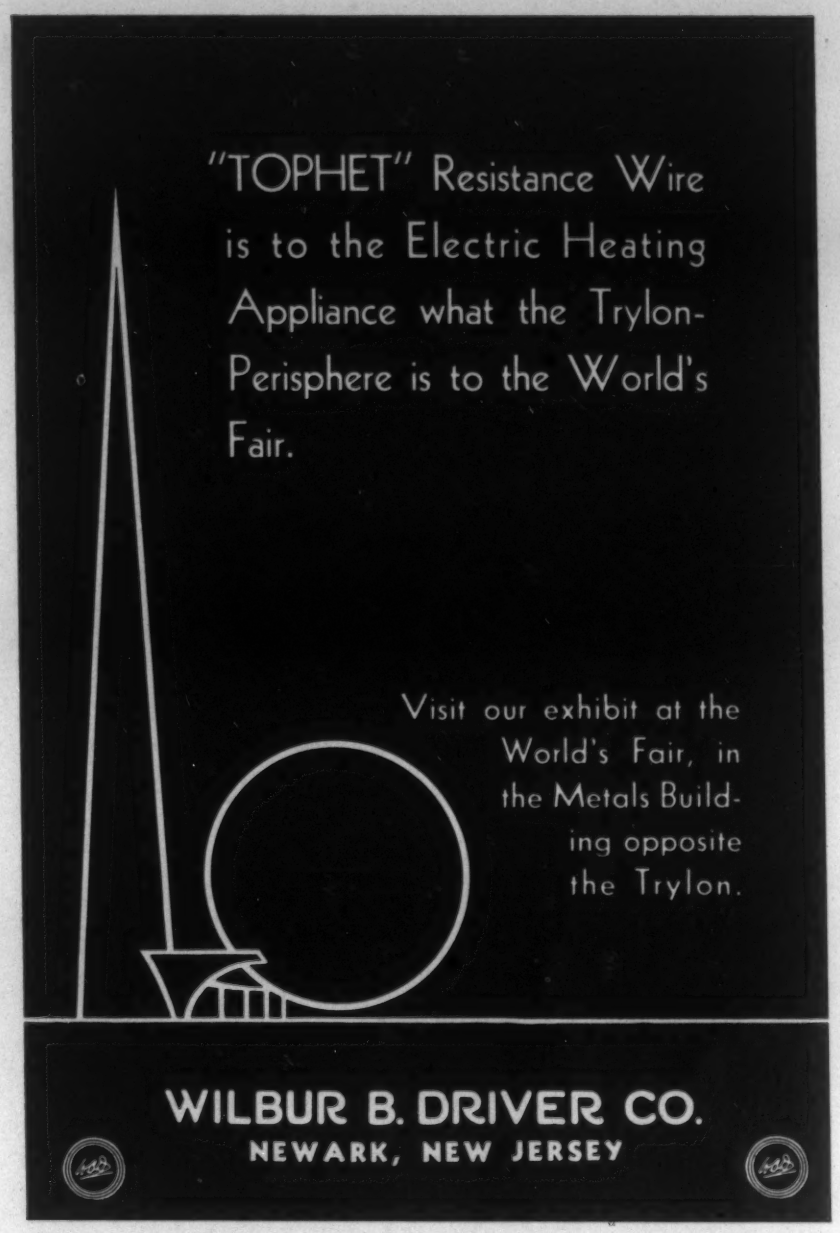
On the Electrode Consumption Due to Arc Discharge. SEISABURO HOH. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 35, Dec. 1938, Abstract Suppl. pp. 55-56. In English. Original research. Relation between electrode consumption due to a.c. arc discharge and the surrounding medium (air, H, N, CO_2, steam, oil vapor) was studied for several electrode materials, such as Cu, Al, C, W and a mixture of Ag + W. Cylindrical electrodes of 3 mm. diameter supported horizontally were spaced 5 mm. apart. The arc was started by the pilot spark discharge and, after several cycles of discharge, it was automatically extinguished by a circuit breaker. After certain lengths of time, the electrode consumption was determined by weighing. The electrode consumption was found to be approximately proportional to the arc duration for a given arc current. The following relation was found: Specific consumption = electrode consumption/(arc current) × (arc duration). The testing results for Cu and W electrodes in 5 gaseous media are graphically presented. With electrode materials that are considered to maintain a "cold cathode arc" (such as Cu, Al, etc.), the specific consumption of electrodes increases greatly (in comparison with air) when the arc discharge takes place in H or a medium liberating H through decomposition, especially with higher arc currents. On the other hand, with electrode materials considered to maintain a "thermionic arc" (such as W, C, etc.) the specific consumption decreases (as compared with air) when the arc is ignited in H. EF (10b)

10c. Effect of Temperature

H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Heat Characteristics of 5 Silicon-chromium-molybdenum Steels. A. E. WHITE, C. L. CLARK (Univ. Mich.) & W. G. HILDORF (Timken Roller Bearing Co.) *Oil Gas J.,* Vol. 37, Dec. 1, 1938, pp. 43-44, 46; Dec. 8, 1938, pp. 43, 45-46, 48. Research. Data for 5 Sicromo steels containing essentially the same amount of C, Mn, S, P and Mo (0.5%), with Si 1.32-1.57% and Cr varying from 1.30 to 4.83% are given for tensile properties at room and elevated temperatures, creep, rupture and ductility in a series of tables. Microstructures are also shown. The results presented are believed to prove conclusively that very acceptable steels for high temperature service can be obtained through the addition of Si, in amounts up to 1.50% to steels containing varying amounts of Cr and .5% Mo. The resulting steels possess a very suitable combination of strength, ductility and impact resistance at room temperature. On the basis of 1,000-hr. creep tests under slightly oxidizing conditions, the addition of Si in this amount lowers the creep strength at certain of the elevated temperatures. Because of the increased surface and structural stability that it imparts, it does, however, increase the load-carrying ability at these temperatures as indicated by the stress-rupture results. Increased Si content does, therefore, increase the actual service life even though it does decrease the creep strength. These steels provide relatively inexpensive materials for use at temperatures up to 1300° F. VVK (10c)



Effect of Type and Structure of Specimen on the Determination of the Creep Resistance of Alloy Tube Steel (Einfluss der Probenform und des Gefügezustandes bei der Ermittlung der Dauerstandfestigkeit von Röhrensonderstahle) E. MAURER. *Archiv. Eisenhüttenw.,* Vol. 12, Dec. 1938, pp. 293-297. Original research. Creep tests were made on 6 Cu-Mo steels for tubing with about 0.10-0.15% C, 0.3-0.6% Cu, 0.3 to 0.6% Mo, one of which contained 0.6% Cr. Various samples were made of the tubes themselves, of flat longitudinal strip cut from the tube walls, and of round bars of the same steels. The stress producing 0.001%/hr. between the 25th and 35th hr. at 550° C. was highest for the round bars (15,000-20,000 lbs./in.^{2}), intermediate for the tubes (12,000-15,500 lbs./in.^{2}), and lowest for the strip (10,000-14,800 lbs./in.^{2}). This was attributed to differences in heat-treatment and resulting structure. The bars were in the hot-rolled condition, not annealed, whereas the tubes were annealed after cold-drawing, although complete recrystallization was not attained in all cases. With proper testing technique and proper precautions as to heat treatment, strip samples cut from tube walls are satisfactory; the whole tube need not be tested. SE (10c)

Evaluation of Time-elongation Curves by Various Methods for the Determination of Creep Strength, and Comparison of the Results with Tests over Long Duration (Auswertung von Zeit-Dehnungskurven nach verschiedenen Verfahren zur Ermittlung der Dauerstandfestigkeit, und Vergleich der Ergebnisse mit Langzeitversuchen) A. POMP & A. KRISCH. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 20, No. 19, 1938, pp. 247-263. Among the many testing methods for the behavior of steel at high temperatures, 12 have been selected as the best and most often applied. These were used to determine the creep strength of a Mo-Cu and Cr-Mo steel at 500° C. in a salt bath furnace and in an air furnace. The tests in the latter are considered more reliable because there is no danger of N diffusion into the steel, such as occurs in the salt bath. The results by 9 methods (those of Kaiser-Wilhelm-Inst., DVM, Swiss Inst. for material testing, National Phys. Lab., Siebel and Ulrich, and Juretzek and Sauerwald, and the determination of 1% total elongation in U.S.A.), check within ±2,800 lbs./in.^{2} Notch-impact test and microstructural examination before and after the test showed no change, and particularly no embrittlement, in the steels even after 1000 hr. loading. 22 references. Ha (10c)

11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Tarnish Films on Copper. J. B. DYESS & H. A. MILEY (Oklahoma A. & M. College) *Metals Tech.,* Vol. 6, Jan. 1939, T.P. No. 1008, 10 pp. Original research. The electrical method of measuring film thickness was used to measure tarnish films on Cu when they were mixtures of Cu_2O, CuO and Cu_2S. S films on Cu were found to have approximately the same thicknesses as O films of the same color and order. Mixtures of O and S films giving uniform tints were found to have total thickness values consistent with the values for O films of similar colors. When O-coated Cu was exposed to a moist H_2S atmosphere in air, Cu_2S was formed: (1) by combining some S with Cu from the base metal, and (2) by replacing some O from the oxides of S. Thin O films containing pores and thick ones with cracks gave less protection against severe attacks of moist H_2S in air than films of the intermediate thickness range. This range of greatest protection was found to be approximately 125 to 275 A.U., the thickness giving maximum protection occurring at about 200 A.U. S films gave more protection against severe attacks of moist H_2S in air than oxide films of equal thicknesses. JLG (11)

Damage to Food-stuffs by Traces of Metals (Schädigung von Nahrungsmitteln durch Metallspuren) W. RUDOLPH. *Umschau,* Vol. 43, Jan. 1, 1939, pp. 17-18. Practical. Metals in food-stuffs can be the cause of more or less serious poisonings, even when involving metals that are ordinarily considered non-poisonous. Cu in very small quantities can have a major effect on the quality of milk; Fe in somewhat greater percentages has a similar effect. Stainless steel, Al and duralumin are not attacked by milk within a range of 5°-85° C. The effects are enhanced when the milk is worked into butter. The metals produce a catalytic effect on the dissociation of the fat. Sn coatings of cans are attacked by their contents when they contain additions of Cu-compounds sometimes used to improve the appearance. The attack by organic and mineral acids on Fe stops automatically if O_2 is not present. By suitable additions to the contents the attack on can material can be reduced. RPS (11)

The Testing of Iron Corrosion under Protective Films (Zur Prüfung der Eisen Korrosion unter Schutzfilmen) J. K. WIRTH. *Chem. Fabrik,* Vol. 11, Sept. 28, 1938, pp. 455-457. Research. A standard test is described that measures the current generated by a film-covered Fe electrode immersed in tap water using a noble metal comparison electrode. The films used contained linseed oil varnish mixed with either Pb paint, red iron oxide, micaceous hematite, ocher, ZnO, graphite or white lead. The films containing the Pb paint and hematite produced the lowest currents, indicating a good protective film. The red iron oxide and ocher films were the poorest. The same trends were established using a base metal comparison electrode. Comparisons of plain steel having various surface finishes were also made. A special surface-treated steel (V2A) was compared with a phosphate-treated steel. The test showed the latter to be far inferior. PCR (11)

Wear in Powdered-Fuel Diesel Engines. *Foundry Trade J.,* Vol. 60, Feb. 2, 1939, p. 112. Descriptive. The method adopted in these experiments is to inject coal ash at a constant rate into the carburetor intake of a single-cylinder gasoline engine running on gasoline under controlled conditions of load, speed, etc., and to measure the liner, piston and ring wear after suitable intervals of time. Some 27 combinations of materials for liner, piston and rings have now been tested in this manner. A wide range of materials has been tried for the liner. It includes Al alloys, unhardened cast irons, hardened and tempered cast irons, nitrided cast iron, nitrided steel, anodized Al and chromium-plated cast irons. The majority of tests have been made with ordinary cast iron pistons and rings, but tests have also been made with very tough, close-grained, cast-iron pistons and rings. The effect of anodizing, tinning, nitriding and Cr plating these components has also been investigated. The results of the tests already made indicate that liner hardness is a vital factor in determining the wear of liner, piston and rings. In general, the harder the liner the smaller is the rate of wear of liner, piston and rings. Thus, the lowest rates of wear of all 3 components have been obtained with chromium-plated and nitrided liners, and the highest rates with Al and unhardened cast-iron liners. AIK (11)

Scaling of Copper-bearing Precious Metal Alloys (Zundern kupferhaltiger Legierungen der Edelmetalle) ERNST RAUB & MAX ENGEL. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde,* 1938, pp. 83-89. Research. The investigations were made on binary and ternary alloys of Cu with Ag, Au and Pd. The type and speed of scaling of these alloys is determined according to whether the predominating diffusion is that of Cu or of O. When O diffusion predominates, no scale layers are formed, but the Cu oxides remain more or less uniformly distributed within the precious metal. Scaling occurs when the diffusion speed of Cu is large. By diffusion of Cu in the scale, a Cu-poor layer is formed on the boundary of scale and metal grain, in which, however, the O-diffusion may prevail. When scaling takes place wholly or predominantly with Cu-diffusion, the oxidation velocity is the same or less than with pure Cu; with scaling characterized by O diffusion, the oxidation speed is considerably larger. The scaling of Ag-rich binary and ternary alloys and some Pd-rich Pd-Cu alloys is controlled by O diffusion, at sufficiently high O pressures. Cu-diffusion predominated in the scaling of Au-rich Au-Cu alloys, ternary Au-Ag-Cu alloys with high Au and low Cu contents, and Au-Pd-Cu alloys with higher Pd content. All the other alloys showed diffusion of both types during scaling. GN + FPP (11)

Corrosion of Steel Chimneys. J. N. WAITE. *Electrical Rev.,* Vol. 123, Aug. 5, 1938 pp. 182-183. Descriptive. In spite of low first cost and low weight of steel chimney, brick or reinforced concrete ones have come into favor in recent years for modern power-plants. This is due to rapid internal corrosion, which occurs with chimneys attached to high-efficiency plant. At Hull, England, in a power-station 5 steel chimneys were found to be corroded so severely that they had to be renewed within 4-5 yrs. of being put into service. Other chimneys, at the same power-station, on older and less efficient boiler plant, had life of nearly 20 yrs. A theory is advanced that with high boiler efficiency, exit gas temperature has been lowered so much that flue-gases adjacent to inner chimney wall were cooled below dew-point. Condensed moisture picked up S, forming H_2SO_3 and causing very rapid corrosion. To prevent this corrosion, new chimneys are of all-welded construction, with an interior lining of ½-in. thick asbestos cement sheets, made to the correct curvature, which are pressed on to a special mastic composition about ⅛-in. thick. Welded instead of riveted construction is used to give a smooth interior and a reasonably true circle. Lining is fastened to 4 equidistant vertical steel strips that are welded to the interior. Steel fastenings are Pb sprayed. Mastic composition remains plastic indefinitely when subjected to 350° F. continuously, and is strongly adhesive. Cost of this method of construction is about 70% above that of a normal steel chimney without any protection. Results have been very satisfactory. MS (11)

The Different Behavior of Purest Aluminum and Commercial Aluminum in Alkaline Solution (Ueber den Differenzeffekt von Reinst aluminium und gewöhnlichem Handelsaluminium in alkalischer Lösung) W. J. MÜLLER, E. LÖW & F. STEIGER. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb. 1939, pp. 1-5. Research. Results of recent tests showed that the corrosion rate of purest Al (99.998%) is not strictly reproducible—it varies up to 50% in different samples; the variations are much smaller in commercial (99.5%) Al. The lowest values of corrosion rate were obtained by applying an external current, probably because of passivation in the pores of the film. Both anode and cathode potential of purest and commercial Al are practically the same, —1.55 and —1.1 v., respectively; the potential difference of the local element comprising both types is, therefore, 0.45 volt. The effect of resistance of the pores and the film which determines the corrosion resistance, is practically the same for purest and commercial Al. Ha (11)

Corrosion of Equipment in Boiler Plants (Korrosionen an Ausrüstungsteilen im Kesselbetrieb) W. SCHUMANN. *Wärmewirt.,* Vol. 20, Jan. 1939, pp. 11-13. Survey. Cast steel, cast iron or Cu are usually adequate, except where unusual corrosion, mechanical or erosion difficulties occur. Corrosion resisting steels are necessary with acid water, unless chemical inhibitors are effective. Dissolved gases may be eliminated by degassing. Cavitation may be avoided by the use of wear resistant materials or by a change in design. P bronze, Cr steel and Cr-Ni steel are usually best for strongly alkaline water. Valve seats may be of nitrided steel if there is no corrosion problem, but must be of 12-18% Cr steel or 18-8 if conditions are very corrosive. Valve cones and seats should be of different hardnesses to prevent galling; often Cr stainless steel is used for one and Cr-Ni stainless for the other. Proper design can do much to avoid wear. JZB (11)

Studies upon the Corrosion of Tin. II. The Effects of other Anions in Carbonate Solutions. GERHARD DERGE & HAROLD MARKUS (Carnegie Inst. Tech.) *Metals Tech.,* Vol. 6, Jan. 1939, T.P. No. 991, 8 pp. (Original research. Time-potential curves were made for NaF, Cl, Br, I, SO_4, HNO_3, PO_4, perborate, and acetate, in concentrations of 0.001 and 0.01 moles/l. in carbonate solutions with a pH range from 8.4 to 11.2. Weight-loss measurements in selected cases from the solutions mentioned were of the order predicted by the potential measurements. Films developed in 0.01 molal Cl solutions with a pH of 9.5 and in chromate solutions provided appreciable protection against alkaline corrosion. For Part I, see also *Metals and Alloys,* Vol. 9, June 1938, p. MA 384 L/3. JLG (11)

Wear Resistance of Gray Iron, Particularly Cylinder Blocks and Sleeves (Abnützungswiderstand von Grauguss mit besonderer Berücksichtigung der Zylinderblöcke und -büchsen) M. v. SCHWARZ. *Giesserei,* Vol. 25, Dec. 16, 1938, pp. 637-642. Tests were made in which the gray Fe sample had a spherical surface that rubbed against a similar seating under controllable conditions. The structure of the gray Fe is the determining factor for wear. A structure as pearlitic as possible, with uniform, fine graphite distribution, pearlite of fine lamellae and narrow mesh of phosphide eutectic, proved to be the best. A high P content gives a high wear resistance. The tests are described in detail and illustrated by the respective micrographs of the structure. See *Metals and Alloys,* Vol. 8, Feb. 1937, p. MA 99 R/9. Ha (11)

The Salt Spray Test. W. H. MUTCHLER, R. W. BUZZARD & P. W. C. STRAUSSER. *Circ. No. 530, Natl. Bur. Standards,* July 1, 1938, (mimeographed), 21 pp. Descriptive of the salt spray test as to principles, equipment, technique and interpretation. Emphasis is placed on the fact that the method was devised for, and is directly applicable only to, estimating in a qualitative fashion the probable relative behavior of materials for use in marine atmospheres. Uniformity in testing procedure is urged. Avoidance of indiscriminate use and of trying to utilize the test data for quantitative prediction of life, are advised. HWG (11)

The Reaction-retarding Effect of Additions of Hexamethylentetramin (Ueber die reaktionshemmende Wirkung von Zusätzen von Hexamethylentetramin) J. ROCH & H. RÖHRIG. *Aluminium,* Vol. 21, Jan. 1939, pp. 31-33. The effect of additions of hexamethylentetramin to acid and alkaline solutions on the attack of Al sheets was investigated. A retarding effect was found in acid solutions; no protective effect could be established in alkaline solutions with NaOH or ammonia. The best effect was found when added to 5% HCl solutions, where 0.1% hexamethylentetramin reduces the attack 90% (measured in loss of material); increase to 5% addition does not increase the protective effect. Ha (11)

Film Inhibitors in Industrial Aqueous Systems. Effect of Chrome Glucosate as a Corrosion Inhibitor in Aqueous Systems where Oxygen Control is Impractical. DAVID W. HAERING (D. W. Haering & Co., Inc.) *Ind. Eng. Chem.,* Vol. 30, Dec. 1938, pp. 1356-1361. Practical research. In many industrial systems water is recirculated over cooling towers so that O control is almost impossible, and the corrosive properties of the water are increased. Organic film inhibitors are being applied in such instances with good results. Because of the mechanical factors, a strongly adherent film is necessary and sodium chrome glucosate has been found to provide a satisfactory film in all respects. Theory of application, practical results and control methods are discussed. 22 references. MEH (11)

Study of the Passivity of Iron and Steel in Nitric Acid Solution. Report XXIV. YOICHI YAMAMOTO. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 35, Dec. 1938, Abstract Suppl. p. 60. In English. Original research. The electrode potential of Fe in HNO_3 solutions was lowered by the addition of urea, HCl or H_2SO_4, and it was confirmed that the ability to make the Fe passive in concentrated HNO_3 is inhibited by this depression of the electrode potential of Fe. By adding small amounts of sodium nitrite to the HNO_3 acid solution, the electrode potential of Fe is raised and Fe becomes passive very readily. For Part XXIII see *Metals and Alloys,* Vol. 10, May 1939, p. MA. EF (11)

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The Dependence of Intercrystalline Corrosion on pH Value, as Exemplified in Aluminum-Magnesium Alloys (Die Abhängigkeit der interkristallinen Korrosion vom pH-Wert, untersucht am Beispiel der Aluminium-Magnesium-Legierungen) H. VOSSKÜHLER. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde,* 1938, pp. 78-82. With discussion. In homogeneous medium-hard Al-Mg sheets with about 9% Mg, a structure is formed upon drawing at 100° C. that tends to pronounced intercrystalline corrosion in artificial seawater. This is not observed in natural seawater, which is explained by the differences of the pH values. The dependence of intercrystalline corrosion on the pH values was established, but it is also shown by tests in natural and artificial seawater of equal pH that other factors cannot be ignored, for dissimilar behavior was observed. GN (11)

Effect of the Film on Aluminum on the Chemical and Electrochemical Behavior of the Metal (Einfluss des Aluminiumfilms auf das chemische und elektrochemische Verhalten des Metalls) A. QUARTAROLI & O. BELFIORI. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb. 1939, pp. 12-13. Experiments, made to explain more clearly the mechanism of the formation of an oxide film on a metal in an acid, are briefly described. The results show that, in pure metals, an electrostatic polarization occurs if an oxide film of sufficient thickness has been formed. Water on bare Al (*i.e.* without oxide film) forms a film of sufficient thickness to cause electrostatic polarization. An Al sample (99.989%), which was not attacked by *N* HCl, showed a short, active reaction in the same HCl solution if treated for 15 min. with 2 *N* NaOH, owing to electrostatic polarization. Ha (11)

Formation of Cracks in a Welded Aluminum Tank Due to Corrosion (Durch Korrosion verursachte Rissbildung an einem geschweissten Aluminium-Behälter) M. BOSSHARD. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb. 1939, pp. 35-36. Descriptive. A tank of an Al alloy with 0.30 Fe, 0.25 Si, 0.006 Cu, 0.005% Zn, and traces of Ti + Mn, in which ammonium sulfide, diluted H_2SO_4 (less than 1% acid) and soap water were stored at different times at a highest temperature of 60°-80° C., developed a crack 4 cm. away from, and parallel to a weld. An investigation established roughness of the inner surface and corrosion through simultaneous action of tensile stresses at such places where the welding flame had reduced the tensile strength and elastic limit of the Al sheet considerably. No intercrystalline corrosion was found. Ha (11)

What Bug Injures the Lead Sheathing of Our Overhead Cables? (Welcher Käfer beschädigt die Bleimäntel unserer Luftkabel?) W. HORN. *Umschau,* Vol. 43, Jan. 29, 1939, pp. 102-103. Descriptive. Damage to Pb sheathing by insects is frequently observed, especially in southern Europe and in California. The damage is considerable and it is hard to locate its origin. The holes in the sheathing are not in themselves serious, but the consequences can be. Wires inside the cable are also attacked; moisture penetrates into the cable and causes short circuits. Spots where the Pb surface is rough and where the cables are suspended in supporting rings are preferred by the bugs. This type of damage is encountered more frequently in locations with warm climate. It is suggested that the surface be oxidized as a protection. RPS (11)

Aluminum as Considered from the Hygienic, Especially the Food-hygienic Standpoint (Die Beurteilung des Aluminiums vom gesundheitlichen, insbesondere vom lebensmittelhygienischen Standpunkt) J. WÜHRER. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb. 1939, pp. 15-24. A general survey was made with regard to the applicability of Al in comparison with Fe, Ni, Cu, Zn and Sn in the manufacture of cooking utensils and other containers of foods. The general conclusion as gathered from experiences in all countries, is that hygienic objections no longer exist to the use of Al in objects coming in contact with raw and cooked foods. A table shows the Al content of vegetable and animal foodstuffs; tea has the highest, 465 mg. in 1000 g. of fresh substance, while drinking water, egg-white, white cabbage and oranges contain less than 1 mg. 100 references. Ha (11)

A Study of the Influence of Carbon on the Corrosion of Steel. W. STEWART PATTERSON. *J. Soc. Chem. Ind.,* Vol. 57, Dec. 1938, pp. 442-444. Original research. Corrosion tests on C steels (0.25-1.23% C) in oxygenated K_2SO_4 (0.01 *N*), with and without mannitol, show that attack is independent of C content. Corrosion is attributed to a specific type of oxide film that induces uniform loss, irrespective of either C content or O_2 supply. Conversely, however, steel specimens, varying only in C, in saturated air media show maximum corrosion on low C steel; minimum attack on high C steel. Suggested explanation is that Fe_3C areas are more resistant and less moisture retaining than ferrite areas. AAA (11)

New Stainless Steel Is Stable in Sulphuric Acid. Y. A. NEKHENDZI. *Stal,* Vol. 8, Aug.-Sept. 1938, pp. 60-68. In Russian. Original research. Steel containing 8% Cr, 18% Ni, 3.5% Mo and 4% Cu is resistant to 50% H_2SO_4 solutions either hot or cold, the loss in weight being less than 0.5 g./m.^{2}/hr. Steel containing 25% Cr and 5% Ni is resistant to cold H_2SO_4 in all proportions. HWR (11)

12 General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

News from the Patent Literature (Neues aus dem Patentschrifttum) E. HERRMANN. *Aluminium,* Vol. 20, Dec. 1938, pp. 873-883. Review of manufacturing and refining processes, alloying, melting and casting, plastic deformation and mechanical plating as reflected in recent patents. Some new free-machining alloys (according to I. G. Farbenindustrie) are composed of (1) 9% Mg, 1.3% Zn, 1.3% Fe, 0.5% Mn, balance Al; (2) 8.0% Mn, 1.75% Zn, 0.8% Fe, 1% Si, balance Al; (3) 10.0% Mg, 1.0% Zn, 0.9% Fe, 0.4% Si, 0.3% Ti, balance Al. Zn is added to prevent formation of coarse, hard aluminide crystals that are ripped out in machining, leaving a rough surface. Excessive oxidation of Al and other non-ferrous metals in the melting process is prevented by generating the necessary heat for melting outside of the shaft furnace by combustion of pitch, pitch or petroleum coke and tar, which are practically free of ash and substances harmful to the metal. These gases are introduced into the furnace in which the metal rests, preferably on a coke bed of low S and ash content. A new piston alloy patented by H. E. Deputy contains 78% Al, 2% Cu, 14% Si, 2.2% Ni, 1.6% Mg, 1.2% Zn, 1% Fe; this alloy is particularly suitable for joining to a reinforcing steel mantle, into which the molten alloy is poured at between 694° and 738° C. 66 references. Ha (12)

Recent Developments in Powder Metallurgy. W. D. JONES. *Metal Treatment,* Vol. 4, Winter 1938-9, pp. 145-149, 152. Review. Metal powders may be compacted by pressing in a die and subsequently heating, or alternatively by hot pressing. By suitable choice of conditions, cold pressings may be caused on heating either to shrink to their theoretical solid density or to expand to form porous masses. If a liquid phase is present in hot pressing, it is often possible to rupture the oxide films and produce surprising physical properties. Compacts of cast iron, pressed in the presence of a small amount of liquid phosphide eutectic, have been made having a tensile strength of 80,000 lbs./in.^{2} Porous pressings, such as low-density precious metal articles having pores so fine as to be invisible, and porous bearings, are obtainable by cold pressing followed by heat-treatment with the presence of a liquid phase. Many electric contact materials, including the recently introduced Ag-Ni aggregates, are made by powder metallurgy. "Emulsion" powders are now being made by atomizing molten emulsions of 2 immiscible metals, such as Cu and Pb. Each atomized particle is composed of numerous fine particles of both component metals. JCC (12)

Annual Review Number. *Foundry Trade J.,* Vol. 60, Jan. 12, 1939. The progress of the metallurgical industry in England and other countries is reviewed. According to the editorial comment, in no country has the foundry industry been really healthy, for where it has been showing gains, the improvement has been due largely to armament orders. The American foundry industry taken as a whole has been depressed, while those of Germany and Italy have been working at high pressure. French and Belgian conditions were far from satisfactory, but both countries report some improvement recently. It appears obvious that Czechoslovakia is determined to retain its position as the major industrial country in Central Europe [*Sic*]. AIK (12)

Developments in the Iron and Steel Industry During 1938. W. H. BURR (Lukens Steel Co.) *Iron Steel Engr.*, Vol. 16, Jan. 1939, pp. 68-82. Review. Both bells of a blast furnace can now be operated by a new single-unit double-drum bell hoist. In a precipitator for efficient cleaning of gas and air from (or for) metallurgical, chemical, or other industrial processing, the electrodes are arranged in parallel planes. As the plate surfaces attract dust they are shaken, loosening the particles and causing them to drop into a hopper. The electrical field is maintained continuously, and cleaning efficiencies up to 99.9% are possible. Measurement and control of temperatures, combustion air, pressure air, etc., in open-hearth operation has shown much progress. Top discards, porosity and secondary pipes are reduced by the use of a powdered refractory material applied to the top of the ingot head immediately after pouring the fully killed steel. A new furnace for heating pipe skelp has considerably lowered maintenance costs. Another furnace development is a gas-fired, sloping hearth pipe reheating furnace with a capacity of 200 lbs./ft.^{2}/hr. Dual temperature control, in which maximum and minimum furnace temperatures are automatically controlled in conjunction with combustion control and pressure control, is used for ingot heating. A cylindrical bell type furnace fired with vertical radiant tubes is used in wide or narrow strip and in wire and rod coil annealing. Round stock 2⅜ in. diameter can be heated for forging in 30 sec. in modern high frequency induction heating furnaces. Zone hardening is accomplished in from 3 to 7 sec. at very nominal costs. A furnace equipped with a walking beam conveyor is used to heat rounds to 2250° F. prior to piercing for continuous seamless tubing mills. Use of insulating brick in soaking pit covers has resulted in longer service life and other economies. Light weight aggregate mixed with Portland cement or high early-strength cement or high alumina cement gives refractory concretes suitable for service at temperatures from 2000° to 2200° F. Equipment for adapting oil and tar firing in soaking pits and reheating furnaces already designed for gas firing has been developed. Several new rolling mills and their electrical drives are described. Many tandem and reversing cold strip mills were built and put into service; one 5-stand tandem mill has been equipped with electrical tensiometers to automatically control the tension between stands. A 4-roll edger was designed to put round or square edges on cold rolled strip in the same operation as when stock is being split or rolled in a single band. A composite type of roll is being developed that has an alloy cast iron body face, which has good finishing properties and is better able to resist breakage and spalling; the body cores, necks and wobblers are so adjusted as to cushion the shell and provide strength to carry torque and transverse stresses without failure. A vertical edger for continuous or semi-continuous merchant and rod mills gives greater accuracy for longer periods of time. The dry process or abrador has been developed for scale removal from hot rolled strip. An electrical device consisting of a number of photo-tubes located beneath the strip detects pinholes as small as 1/64 in. on a moving strip at speeds up to 900 ft./min. Strip steel with electro-deposited Cu, Ni and brass is now on the market. Proper technique, procedure and efficiency are being stressed in welding. A new electric welding process uses heat generated by the passage of current from an electrode to the work. The end of the electrode is constantly covered by a highly resistant conductive material; welding action takes place without an open visible arc and without sparks, spatters, smoke or flash. Tabulation and statistics are given on the installations of motors over 300 h.p. applied to main roll drives and on electrically operated cranes in the industry during 1938. CBJ (12)

Aluminum Powder as Pigment for Paints. *Light Metals*, Vol. 2, Mar. 1939, p. 94. Descriptive. The unique and useful properties of Al pigment are chiefly due to the manner in which the powder is made. High grade Al sheet is stamped under heavy pressure in stamping machines that also give a spinning action to the rams, thus aiding in tearing up the flakes. Stearic acid is used as a lubricant. The "leafing" characteristic of Al paint is obtained only after a polishing operation. Unpolished powder, while showing some tendency to "leaf," does not leaf so well as the polished powder. By leafing is meant the tendency of the Al flakes to interlock like a mass of fallen leaves. The medium in which the flakes are suspended is also important. It must not dry before leafing is completed, nor must it be acid, since acid attacks the polished film and tends to destroy leafing. AUS (12)

An Historical Review of the Bessemer Process (En historisk återblick, särskilt beträffande bessermerprocessen) CARL BENEDICKS. *Jernkontorets Ann.*, Vol. 122, No. 10, 1938, pp. 552-559. Primarily a book review of "Swedish Iron through the Ages" (Det svenska järnet genom tiderna) by Jalmar Furskog. Benedicks concludes that Kelly in America circa 1849 was the first to blow air into pig iron, and took out his patent in 1856 after learning of Bessemer's American patents. The use of the Bessemer process for production of quality steel was solved in Sweden by G. F. Göranson, July 18, 1858. Copious references are made to the older Swedish literature. HCD (12)

Metallurgical Developments in 1938. A Review of the Non-ferrous Field. BRUCE W. GONSER & ALAN U. SEYBOLT. *Metal Ind., London*, Vol. 54, Jan. 13, 1939, pp. 29-33. Up-to-date review of progress in non-ferrous metals. Taken broadly, there appear to be more new developments in recent years in fundamental than in applied non-ferrous metallurgy. Aside from the constant development of new equipment for testing and production, perhaps the most important general development is improved raw material. Recent developments in the process of production of these are the electrolytic Mn process using fairly low grade ores, the new thermal extraction of Be by decomposing Be_2C, production of Mg by thermal reduction of the oxide and the recovery of some of the more or less rare metals by the hydride process. Continuous casting continues to be one of the foremost developments in simplifying the production of non-ferrous strip and rod. Recent application of this in the production of Al strip for foil has been successful. Extreme close thermal and mechanical control is required. Few entirely new developments have occurred in joining non-ferrous parts. Automatic welding of galvanized steel has been developed, using heavily-tinned Si-bronze welding wire (95% Cu, 4% Si, 1% Mn). The use of Al base rivets of 2.1% Cu, 2.1% Mg, 0.8% Si, balance Al, which can be driven into place after 24 hrs. without cracking since age-hardening does not start until after 9 hrs. at 70° F., has been suggested to overcome difficulties of riveting with dural. The use of non-ferrous metals to protect steel from corrosion is receiving active attention, such as electroplating Sn on steel strip, hot dip Sn, Al-coated steel, electrodeposited Ag, deposition of Sn on steel from the vapor phase and the use of Be as a surface hardener for Fe and Ni alloys. Improvements and developments in alloys include "Z"-nickel, Ag-Mg alloys (alloys of 8.5% Al, 4.2% Ag, balance Mg gave 60000 lbs./in.^{2} tensile with 5% elongation), and Te-Pb containing Cu (to prevent coarse crystallization during welding). Addition of 1% or less Te to Sn improves creep resistance and increases the work-hardenability. Si-Cu has become established for chemical construction. The necessity of a change in conception in the α solid solution line at temperatures near the solidus of the Cu-Si constitution diagram was shown. The electron microscope demonstrated that twins in Ni-Fe alloy, annealed after cold work, formed during recrystallization and were not subsequent to crystal growth as some had supposed. Studies of age-hardening show the aging of dural proceeds in 3 steps: (1) A knot or nucleus formation that distorts the lattice prior to precipitation, (2) local precipitation along grain boundaries and slip planes, and (3) general precipitation. Mg_2Si exerts hardening action only during aging at elevated temperatures. In Al alloys containing 4% Cu, 2% Fe prevents aging at room temperatures but an additional 0.03% Mg restores the age hardening susceptibility. Thermal processes below the melting point involve solid diffusion, and the determination of diffusion rates have real practical significances. The diffusion rate increases with increase in concentration of solute. Recrystallization, grain growth and twinning may be induced in a single phase by diffusion if the volume change that accompanies this diffusion is sufficiently large. Diffusion along grain boundaries in general is more rapid than through the grains. 122 references. RWB (12)

Raw Materials for the Magnesium Industry—I. JOHN REYNOLDS. *Aluminium & Non-Ferrous Rev.*, Vol. 4, Jan. 1939, pp. 43-46. Survey. Sea water and bitterns (obtained from salt-lake water) contain considerable amounts of Mg. The vast deposits of salts of alkali and alkaline earth salts in Germany (Saxony) are, at present, the world's most readily available source of Mg. Chief mineral salt from which Mg is obtained is carnallite, double chloride of K and Mg. KCl is extracted by leaching with boiling water, settlement decantation and selective crystallization. Carnallite contains 6-8% Mg, in excellent form for electrolytic production. Magnesite is the most abundant Mg mineral that does not contain objectionable constituents. It must often be extracted from narrow veins, necessitating careful mining methods. There are deposits in North America, Austria, Greece, Russia, Canada, Mexico, Sweden, Japan and Sudan. Removal of troublesome impurities (Ca, $FeSiO_2$) should be performed in the earlier stages. Dolomite is a less important source. Brunite ($MgO.2H_2O$), as found in Nevada, contains 30% metal and is a potential source. RPS (12)

Events in a World-wide Field. A Survey of the Situation in the Major Mining Countries During 1938. *Eng. Mining J.*, Vol. 140, Feb. 1939, pp. 52-66. In the United States there was a sharp drop in the domestic base-metal output in the first half of the year, but a marked uptrend developed in the latter half. In Canada expansion in Au mining was the greatest in her history, and Cu, Zn and Pb outputs were at a new peak. Uncertainty prevails in the Mexican mining and oil industries. In the Philippines the output of Au is up 25%. The base metal industry showed growth during 1938. The African mining industry prospered in 1938. In Australia the Au mining industry expanded. WHB (12)

books

Pure Metals (*Reine Metalle*)

A. E. van Arkel

Julius Springer Verlag, Berlin, 1939. Paper, 6¾ x 9½ in., 574 pages. Price 48 RM.

This is edited by van Arkel of the University of Leyden, who has done much in the preparation of metals of high purity. Several sections are by him, the others by a score of other authorities. The bulk of the book is in German, but several chapters are in French, while that on technology of copper, by Hayward, and that on tin, by Macnaughtan and Daniels, are in English, the author's language being used in these cases. This results, on page 399, in the first paragraph being in English, the rest of the page in German. The opening discussion, on the metallic state, by Borelius of Sweden is, however, in German. After some contemplation of what an element must be like to deserve being termed a metal, the decision is made to include in this volume boron, selenium, tellurium and other elements not always classed as metallic, without worrying whether they are metals or not.

For each element there is a discussion of methods of preparation and of the degree of purity so far attained by the use of each. The physical constants are given, with selected values or citation of conflicting data, the mechanical properties are briefly discussed, sometimes with a little comment on the effects of impurities, and a very brief word given on uses, where uses exist for the unalloyed element. A selected bibliography follows, cited only by author's name and place of publication, without giving the title, a practice somewhat irritating since the text reference may relate only to some minor point in a comprehensive article. References are plentiful; there are 118 on iron, 87 on cobalt, 92 on nickel, 120 on copper, 203 on zinc and cadmium.

In the discussion of Cu, three lines are given to hydrogen embrittlement of oxygen-bearing metal, and no reference at all is made to argentiferous copper. Exclusive of the bibliography, the section on iron covers but 24 pages. This brevity may be an advantage, since it allows space for including all the metals into one volume. Because of this inclusiveness, the book is convenient and useful for reference.

It must be granted that most of the space is required for recording data on properties that are generally of more interest to the physicist than to the metallurgist or metallurgical engineer. However, the latter often does need to have such data, together with more comment than is given in tabular form in handbooks. It is better, too, to have recent data hand-picked as most probable values by authorities of the standing of Van Arkel and his collaborators, instead of older data, less carefully culled.

This is a reference book which the average metallurgical engineer will not refer to very often, so it will probably find more purchasers among plant and institutional libraries than among individuals. That distribution is thus likely to be small may account for the high price.—H. W. GILLETT.

Report for 1937-1938 of the Department of Scientific and Industrial Research

British Library of Information, New York, 1939. Paper, 6 x 9½ in., 203 pages. Price 90c.

The work of 10 British research organizations supported by public funds, such as the National Physical Laboratory, Forest Products Research Laboratory, etc., and 22 industrial research associations to which government grants are made, including the British Non-Ferrous Metals Research Association, British Cast Iron Research Association, and the British Iron & Steel Federation, is covered by this report. It is pointed out that much of the work is of highly technical nature so that experts alone can readily understand the value of the information produced. As this report is aimed for the general public only a few of the investigations are discussed, and those that are mentioned are merely listed. Unless the work has been published, when a reference is given, about all this publication does is to name the topic of investigation.

Among the metallurgical topics mentioned are: A simple and effective method for measurement of temperature of liquid steel, devised by the N.P.L.; cupola production of iron of controlled fine graphite structure, which seems to be on the road to solution by the Cast Iron Association; and production of green patina on copper blackened by exposure, by spraying with thionyl chloride, reported by the Chemistry Research Board. Corrosion studies, high temperature properties of metals, lubrication and wear of bearings, properties of light alloys, etc., are carried along as in former years.

The available funds for research in the year reported were about as follows: Cast Iron Association $110,000, Non-Ferrous Association $145,000, Iron & Steel Federation $190,000. This last figure is expected to be raised to $300,000.

Investigations in other than metallurgical fields, to which the bulk of the report is devoted, may not interest our readers, but one such project did interest the reviewer. A drainage scheme in Ireland was obstructed by an existing eel weir, and it was suggested that the migrating eels be diverted into a smaller trap by electric currents. A laboratory set-up 15 ft. long at the N.P.L. seemed to work, and a pilot plant was tried in a stream 15 ft. wide, using "non-migrating" eels, with 70 per cent efficiency. A scale model of the 400-ft. wide stretch was set up and finally the actual *river* installation made. The results in the actual eel-migration were negative, no eels were diverted, but some were killed. It is concluded that it has only been established that eels can be electrically diverted on a small scale. The account does not reveal whether the use of a few electric eels as bell-wethers was attempted. At any rate, there are eels in Ireland, though they seem to prefer other than electrical diversions.—H. W. GILLETT.

The Principles of Electrochemistry

Duncan A. MacInnes

Reinhold Publishing Corp., New York, 1939. Cloth, 6¼ x 9½ in., 478 pages. Price $6.00.

In the preface, the author emphasizes that the "subject of electrochemistry has become so extended" that it was necessary to "severely limit the range of topics considered."

Accordingly, the author has confined himself to the principles of electrochemistry of aqueous solutions, in particular, very dilute solutions. His treatment of these has been most thorough and is based on many years of careful application to the subject. Among the 24 chapter headings are included the Laws of Faraday, Electrolytic Conductance, Electrolytic Transference, the Principles of Thermodynamics, the Debye-Hückel Theory, Concentration Cells, Standard Electrode Potentials, Determination of pH, Electrometric Titrations, the Dielectric Constants of Liquids, Electrokinetic Phenomena and Passivity and Overvoltage. Most of the experimental data referred to in the book are of relatively recent origin, obtained during the last 10 or 15 years.

To all interested in the physical chemistry of solutions, this book is highly recommended.—COLIN G. FINK.

Selected Methods of Chemical Analysis for the Iron and Steel Industry

(Ausgewählte chemische Untersuchungsmethoden für die Stahl- und Eisenindustrie) Second Edition

Otto Niezoldi

Julius Springer Verlag, Berlin, 1939. Paper, 5½ x 8¼ in., 175 pages. Price 6.90 RM.

The first edition of this book was published in 1936, and was reviewed in METALS AND ALLOYS, Vol. 7, Nov. 1936, page MA 554 L/6. This second edition follows the same general outline and method of presentation. The older methods have been retained, but literature references since the last edition are added in many instances. The first edition was divided into 3 parts: The first covered iron and steel; the second, common non-ferrous metals and alloys; and the third, slags, ores, boiler scale, dolomite, fuels, etc. The second edition adds a fourth part on the preparation and standardization of various volumetric solutions.

The principal new analytical methods added are the potentiometric determinations of Ni, Cr, V, Mo, Co, and Ti, and a photometric method for determining Mo. A new section is devoted to the analysis of magnesium-base light metal alloys.

The book for the most part outlines routine and not umpire procedures. Usually a few notes are included with each outline. Directions are brief and to the point. It is not a textbook, but German-reading steel plant chemists should find it useful.—JOHN D. SULLIVAN.

Detection and Determination of Foreign Elements in Iron and Steel

(Nachweis und Bestimmung von Fremdelementen in Eisen und Stahl)

Gmelins Handuch der anorganischen Chemie, Vol. 8, System No. 59, (Iron), Section FII, Part 1

Verlag Chemie, G.m.b.H., Berlin, 1938. Paper, 7 x 10¼ in., 164 pages. Price 19.50 RM.

The first section dealt with analyses for C, Si, Mn, P, As, Sb, Bi, S, H, N, and O. This part of the second section covers alkalies, alkaline earths, B, Be, Zr, Hf, Se, Te, Ga, In, Tl, Ge, Re, Hg, Ag, Au, Sn, Pb, Zn, Cd, U, Ce, Cb, Ta, W, Mo, Cr and V. The next part, to be published soon, will deal with Ni, Co, Cl, Th, Al, and Ti, and with special analytical methods. The authors of this part are J. Forster, F. Walke, W. Corleis and E. Deiss.

The literature has been reviewed to May, 1938. In the cases where the elements listed are not likely to be present in steel, methods applicable to ores containing them are nevertheless included. The treatment is essentially bibliographical, very many alternative methods are mentioned without indicating much as to their relative value. The next part, however, is to contain a listing of standard methods of various countries.

The literature cited is analytical rather than metallurgical, though the metallurgical references will be helpful in the cases of some of the more uncommon elements. It is primarily a book for the analyst who is up against the determination of elements outside the usual run.—H. W. GILLETT.

Grinding (*Schleifen*)

Kurt Potyka

Carl Hanser Verlag, Munich, 1939. Paper, 5¾ x 8¼ in., 63 pages. Price 1.80 RM.

This is No. 7 in the "Werkstoffkniffe" series. It contains practical suggestions on type of wheel, speeds and feeds, design of parts for satisfactory finishing by grinding, and a general discussion of centered and centerless grinding, grinding of flat surfaces and of inside grinding. The grits and speeds suitable for different classes of material to be ground, ranging from light alloys to hardened steel are given in tables, but aside from this there is no discussion of any metallurgical phase of the subject.—H. W. GILLETT.

Rolling Mill Practice (*Walzwerkswesen*) *Vol. 3*

J. Puppe

Verlag Stahleisen M. B. H., Düsseldorf, 1939. Cloth, 8¼ x 11 in. 669 pages. Price 72 RM.

This is the final volume of a sort of rolling mill encyclopedia prepared under the sponsorship of the Verein deutscher Eisenhüttenleute, part of the *Handbuch des Eisenhüttenwesens.*

Vol. 1 appeared in 1929, Vol. 2 in 1934. These dealt especially with the principles of rolling and with the production of structural shapes, rails and the like. Vol. 3 deals particularly with flat rolled products and with tubing, together with a chapter on rolling railway wheels. It is fortunate that flat rolled products were left for the final volume, since it is in this field that changes have been most recent and most radical. The various chapters are written by a dozen specialists, for example, that on cold-rolled strip is by A. Pomp.

Photographs of rolling mills, and line drawings of mills and plant lay-out are used profusely, to give a clear idea of the technique used, not only in actual rolling, but in heating, pickling and similar operations. While the historical aspect is not neglected, chief emphasis is put on modern practice. Since many of the most notable advances in flat rolled products hail from the U. S., American practice is extensively discussed, continuous mills, Steckel mills, radiant tube annealing furnaces, controlled atmospheres, etc., being dealt with more fully and more accurately than one might expect in the evident absence of an American collaborator. The reviewer fails to find reference to the Morgoil bearing, but other major omissions are few.

The treatment is primarily from the standpoint of the metallurgical engineer concerned with the mechanical aspects of rolling. Tables, curves, formulas and nomograms are given for energy required, roll pressures, lengthening and widening per pass and other matters that can be so handled, while mechanical devices of all sorts are featured. Matters of structure, principles of annealing and normalizing, and testing of the products, tinning and galvanizing; roll materials, preparation and causes of failure, are a bit more sketchily dealt with and reliance put upon selected bibliographies for further details. Tonnage carbon steels are those chiefly considered; the discussion of alloy steels and especially of stainless steels is limited.

The main topics are: Universal plate, hot-rolled sheet and strip, (silicon steels are included), manufacture of seamless tubes (extensive discussion of many methods) and of welded tubes (this section is very incomplete), wheel-rolling, and cold rolling of strip (this last is quite comprehensive). A 20-roll cluster mill with 0.2-in. diam. working rolls is illustrated.

Because there is no other single-volume description so complete, because of the large number of illustrations which aid so much in clarifying the discussion, and because of the excellent book-making, the volume will be worth its price to rolling mills and to mechanical and metallurgical reference libraries.—H. W. GILLETT.

Technical Analysis of Ores and Metallurgical Products

Franklin G. Hills

Chemical Publishing Co., Inc., New York, 1939. Cloth, 5¾ x 9 in., 250 pages. Price $3.00.

This edition is almost exactly the same as the first edition, which appeared in 1937 in cloth cover but mimeographed form and was reviewed in METALS AND ALLOYS, Vol. 9, Feb. 1938, page MA 122. The only additions in the new edition are (1) 7 pages on Mineral Analysis of Water, (2) inclusion of potassium iodate, sodium carbonate, standard alkali, standard acid and N/10 iodine in the section on Standard Solutions and Standardizing, and (3) a table of 1938 atomic weights.

An improvement has been made in printing but not all typographical errors have been eliminated; thus, on page 245, the factor AgCl to Ag is still given as 0.57. The illustrations have been better placed although many of them still carry no captions.

As this book is substantially the same as the original edition the reviewer makes the same recommendation he did for that: "Plant chemists, especially in small laboratories that do not have standardized procedures, will find the book useful in the analysis of ores and metallurgical products."—JOHN D. SULLIVAN.

Metals *(in two volumes)*

Harold Carpenter and J. M. Robertson

Oxford University Press, New York, 1939. Cloth, 6½ x 10 in., 1485 pages. Price $35.00.

Thirty-five dollars is a lot of money, but these are big volumes. The authors are professor of and lecturer in metallurgy, respectively, at the Royal School of Mines, London. The subject is physical metallurgy; no attention is paid to reduction metallurgy. The primary topic might be termed the philosophy of metals, since the authors are more concerned with making the reader understand what is going on during the crystallization, the deformation, and the heat-treatment of metals and alloys than with the engineering properties obtained. The alloys chosen, however, are those of commercial importance and what has been accomplished in the handling of the alloys is evaluated in terms of engineering properties.

The avowed purpose is "to make it possible for any one with some scientific or technical training, but without any previous knowledge about metals, to begin at the beginning and build up a moderately comprehensive knowledge of the subject as he reads". This is rather well accomplished, but this doesn't mean that the "reading" won't have to involve a good many hours of study.

The large first volume (823 pages) is devoted to generalizations, somewhat discursively set forth. The authors evidently decided to have their say without particular regard to the space required, so that when a subject is closed, the reader tends to feel that about all the pertinent evidence has been marshaled upon that particular mechanism of physical metallurgy. Sometimes the discussion could have been improved by greater terseness and the use of well known diagrams; for example, the discussion of transformations in steel at constant sub-critical temperature would have been facilitated by the showing of S curves.

On the whole, the discussion of principles is excellent, particularly because the authors follow the argument of a given article in the literature only as far as they consider that the experimental facts support the argument. Their refusal to go along into realms of pure, even though plausible, speculation, is one of the most refreshing features.

Vol. 1 deals with crystal structure, microstructure; deformation and fracture; time, temperature and deformation; constitutional and structural changes; mechanical testing; oxidation and corrosion; casting; heat treatment and mechanical treatment. The discussion is quite general, applying equally to ferrous and nonferrous alloys. Vol. 2 deals with industrial alloys, starting with the Fe-C system and heat-treatment of steel; alloying elements, inclusions and grain size; composition, treatment, and properties of steels in general; cast irons; copper-base alloys; alloys of Al, Ni, Pb, Sn and Mg. The latter part of the second volume is illustrative rather than exhaustive. High speed steel, for example, gets less than two pages. Although creep phenomena have been exhaustively and intelligently discussed in Vol. 1, and oxidation phenomena likewise discussed at length, the two headings, "heat-resisting steels" and "heat-resisting alloys" each have less than two pages each.

The engineering-minded reader will find some value in the book because a good deal of pertinent material that he probably has not had time to dig out of the literature is collected here, but even so it is not in the handbook, tabloid form in which he would most appreciate it. The thoughtful young physical metallurgist who is willing to take time to assimilate the whole book, will most appreciate it, even though it may take him months to wade through it. The old-timer who has followed the literature anyway will use it for its careful, well-balanced summations.

For such use, however, the index should have been more extensive, since many topics get side comment in several places without index entries. This is a bit irritating, as is (to an American reader at least) preponderance of use of English data and references when equally convincing American data are available. The authors excuse their limitation of literature references on the score of lack of space, a valid excuse, but it does make the book somewhat less useful to the American reader. The German reader will probably feel much the same.

The most irritating thing is that each volume is too heavy to hold in the hand. Volumes that should be studied before the fireside night after night ought not to require that one sit at a desk to use them. At the price charged, the publishers should have bound this in three parts instead of two. By omitting certain material, it could have been condensed into two more wieldy volumes, but some of its value to the philosophically inclined reader would have been lost.

The price will deter many an individual who would profit by study of the book, and who would like to own it so he could pick it up or lay it down at will. Even at the price, any metallurgical library with any pretension toward completeness, cannot pass it by.—H. W. GILLETT.

German Engineering Society Yearbook—1939 *(VDI Jahrbuch—1939*

VDI-Verlag G. m. b. H., Berlin, 1939. Paper, 6 x 8¼ in., 298 pages. Price 3.50 RM.

Approximately 50 pages of this tabloid statement of engineering progress are devoted to metallurgical matters. The volume is primarily a bibliography of recent, chiefly 1938, publications in all engineering fields. German references vastly predominate, but those in other languages are not neglected.

The references do not give the author's name, and the text merely states the subject reported without attempting to state the results. Notwithstanding these limitations, it is a very helpful finding list, worth its price to technical libraries.—H. W. GILLETT.

Proceedings of the 6th Summer Conference on Spectroscopy and its Applications

G. R. Harrison

John Wiley & Sons, New York, 1939. Cloth, 7½ x 10 in., 172 pages. Price $3.00

Previous conferences at M.I.T. on spectroscopy included direct discussion of metallurgical analysis by this method. The conference of 1938 had no papers bearing directly on this subject, although details of technique applicable to such problems are dealt with.

However, if one is interested in writing detective stories, the first two papers, on use of spectroscopy in criminal investigations, will supply material for a dozen thrillers.—H. W. GILLETT.

Operating Practice Reference Sheets *(Betriebstechnische Sammelmappe)*

VDI-Verlag G.m.b.H., Berlin, 1939. Looseleaf, 8½ x 11¾ in., 24 pages. Price 2.40RM.

This little volume presents tabloid information, previously published in "data sheet" form in *Maschinenbau*. Metallurgical matters included are improvement of fatigue resistance of bolts, lubrication sharpening of milling cutters, files, packing light metal sheets to avoid scratching, imperfections in steel, spark testing and hardness testing. The information is too elementary and too brief to be of interest to experts in these lines.—H. W. GILLETT.

Platinum *(Platin)*

Gmelins Handbuch der anorganischen Chemie, 8th Ed. (System No. 68, Platinum) Part A, Section 1, History and Occurrence; Part B, Section 1, Physical Properties.

Verlag Chemie, Berlin, 1939. Paper, 7 x 10 in. Part A, 145 pages, Price 16.50 RM.; Part B, 72 pages, 8.25 RM.

Part A deals wholly with the geological distribution of platinum deposits, and chiefly with those of Russia; there is evidently more to come on this phase, since the Canadian platinum deposits have not been reached in these 145 pages.

Part B relates to the metal itself and covers only part of the physical (rather than the mechanical) properties, which are to be continued in the next section. The completeness of the whole treatment can be seen from the space used in this part. The literature is covered to August 1938, extends back to a publication of Bresson in 1787, and ranges from that early piece to modern papers on the diffusion of heavy hydrogen. The inclusion of references to many obscure publications indicates how thoroughly the literature has been scanned for data.—H. W. GILLETT.

Books Dealing with Materials and Technique for Protecting Metals from Corrosion Losses

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In charge of Technical Development Beck, Koller and Company, Inc. Formerly Director of Institute of Paints and Varnish Research, Berlin

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CURRENT news

Dr. H. A. Schwartz Signally Honored

J. E. Hurst, past president, Institute of British Foundrymen, announced at the annual dinner of the American Foundrymen's Association, held at Hotel Gibson, Cincinnati, O., on Wednesday, May 17, that the "E. J. Fox Gold Medal" of the Institute was to be awarded to Dr. Harry A. Schwartz, manager of research, National Malleable & Steel Castings Co., Cleveland. This medal is being awarded to Dr. Schwartz in recognition of the very valuable work he has done in research developments in the field of malleable cast iron and the presentation is to be made at the time of the International Foundry Congress in London on June 13.

The medal was established a few years ago by J. E. Fox, managing director, Stanton Iron Works Co., Ltd., and its establishment commemorated the development of centrifugal castings in Great Britain. Previous recipients of the medal are Thomas Turner, professor emeritus, University of Sheffield, and J. E. Hurst, technical director, Bradley & Foster Co., Ltd., England. The award is made by the Council of the I. B. F. on the recommendation of assessors, the two assessors this year being Sir H. C. H. Carpenter, Imperial College of Science and Technology, London, and Sir William J. Larke, director, British Iron and Steel Federation.

In 1930, Dr. Schwartz was awarded the John A. Penton Gold Medal of the A. F. A.

An Honor for Doctor Jeffries

Dr. Zay Jeffries, eminent metallurgist, has been elected to membership in the National Academy of Sciences. Membership in the academy is limited to 350 members, and is recognized as the highest scientific rank an American can receive. The academy compares with the Royal Society of Great Britain and the French Academy.

The election was announced at a luncheon in the Union Club in Cleveland last month. In congratulating Dr. Jeffries, the president of Case School of Applied Science, Cleveland, Dr. William E. Wickenden said: "You are inheriting the place of two world figures. As a Clevelander you are succeeding Ambrose Swasey, eminent industrialist, patron of science and doer of good works; as a scientist you are succeeding Albert Sauveur, preeminent in the art of metallography."

Dr. Jeffries has contributed numerous important developments in the science of metals as a result of his research with tungsten lamp filaments, high strength aluminum alloys, the application of X-ray analysis to metallurgy, and so on.

Dr. Frary Awarded Acheson Medal

The announcement of the sixth award of the Edward Goodrich Acheson medal and $1,000 prize to Dr. Francis Cowles Frary was made at the Electrochemical Society's spring meeting at Columbus, Ohio, in April. Previous recipients of this highest recognition in electrochemistry are: Dr. Edward Goodrich Acheson, for his work on artificial graphite; Dr. Edwin F. Northrup, for the invention of the high frequency electric furnace; Dr. Colin G. Fink, for his contributions to electrochemistry; Dr. Frank J. Tone, for his work on carborundum; and Dr. Frederick M. Becket, for his contributions to electrometallurgy.

Dr. Frary is the director of the research laboratories of the Aluminum Co. of America and he is well known for his achievements in the metallurgy of aluminum. The so-called Frary metal is a tin-free, bearing metal used extensively in place of babbitt.

Dr. Frary was born in Minneapolis, Minn., on July 9, 1884. He obtained his degree of doctor of philosophy at the University of Minnesota in 1912. Before entering the employ of the Aluminum Co. of America he was professor of chemistry at the University of Minnesota and, later, research chemist at the Oldbury Electrochemical Co., Niagara Falls, N. Y. During the Great War he was captain of the Ordnance Department, Officers Reserve Corps, and Major in the Chemical Warfare Service. He is a past-president of the Electrochemical Society and has contributed a number of important papers on the electrometallurgy of aluminum.

Dr. Stareck Awarded Longstreth Medal

Dr. Jesse E. Stareck, now engaged in research at the laboratories of United Chromium, Inc., Waterbury, Conn., on May 17 received the Edward Longstreth medal of the Franklin Institute in Philadelphia for his discovery of electrolytic color plating, a new method applicable to the art of coloring metals. This process has been made available commercially by United Chromium, Inc., and has found widespread use for the production of "Electrocolor" articles.

Electrochemists Elect New Officers

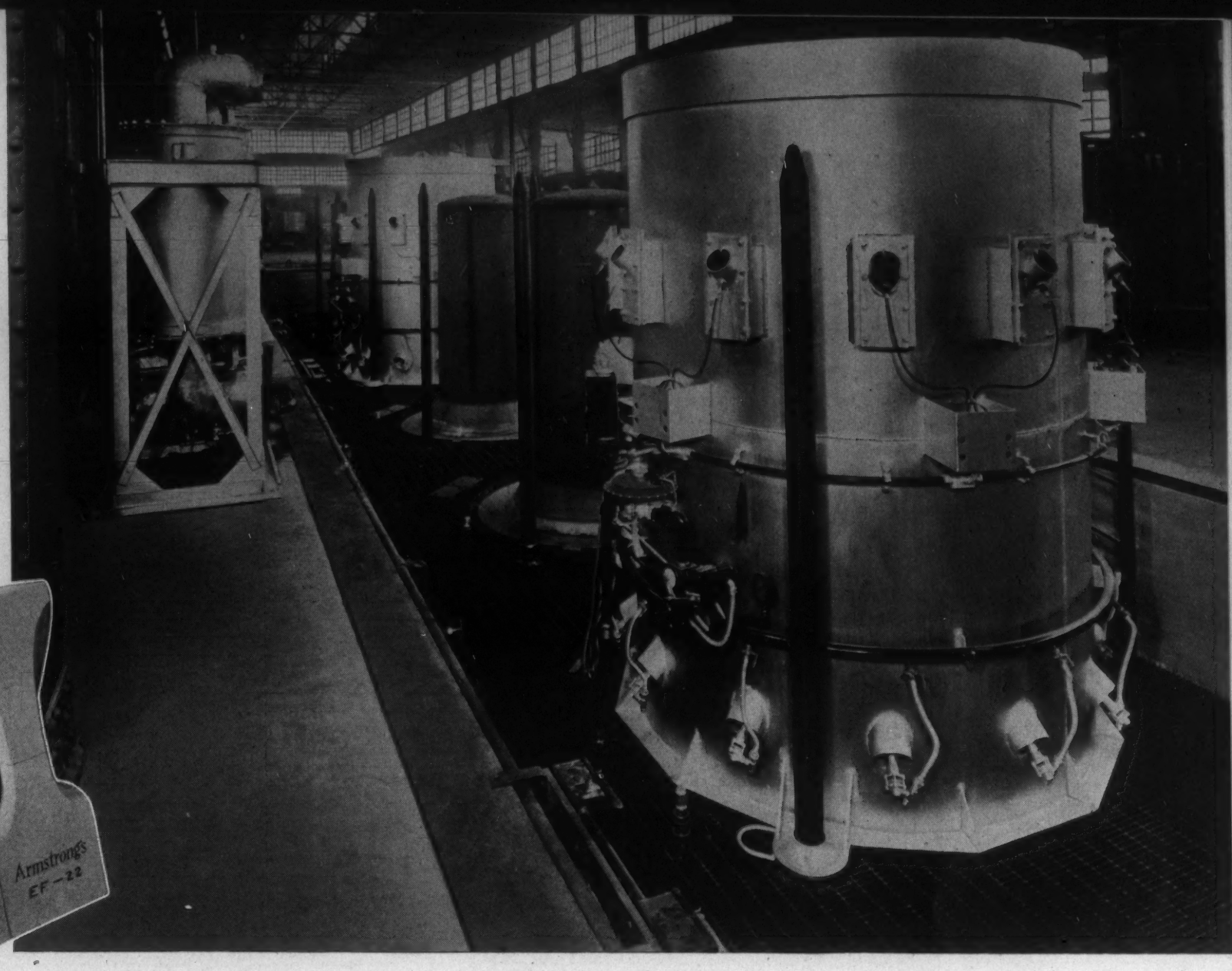
At the annual meeting of the Electrochemical Society held at Columbus, Ohio, in April, the following new officers of the Electrochemical Society were elected: President: H. Jermain Creighton, Swarthmore College, Swarthmore, Pa.; vice-presidents: D. A. Pritchard, Montreal, Canada, Alexander Lowy, Pittsburgh, J. D. Edwards, New Kensington, Pa.; managers: C. E. Williams, Columbus, Ohio, K. G. Soderberg, Detroit, Mich., J. A. Lee, New York City; treasurer: Robert M. Burns, 463 West St., New York City; secretary; Colin G. Fink, Columbia University, New York City

Dr. H. Jermain Creighton, newly elected President of the Electrochemical Society, was born in Dartmouth, Nova Scotia, on March 2, 1886. He has headed the chemistry department of Swarthmore since 1928. The Franklin Institute awarded him the Longstreth Medal in 1918. He is the author of one of the very best books on electrochemistry, which is used in many American and British universities. Dr. Creighton has just been awarded the Howard N. Potts gold medal, "in consideration of his distinguished work in developing a process for the electrolytic reduction of simple sugars on a commercial scale."

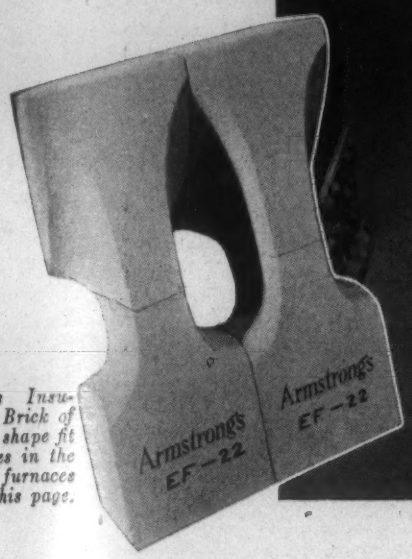
Additions to Battelle's Staff

George R. Kinzie, economist and business analyst, has been added to the staff of Battelle Memorial Institute, Columbus, Ohio, in order to aid in the consideration of economic factors related to the problems of industrial research. Mr. Kinzie, formerly associated with Standish, Racey, and McKay, Inc., investment counsel of Boston, will cooperate with the various technical divisions of the Institute. Problems in industrial economics as related to technical research and development will be referred to him for analysis.

(Continued on page MA 384)



Two cylindrical bell type furnaces and seven bases built by the Lee Wilson Engineering Company of Cleveland for Detroit Steel Corporation. They are used for high carbon strip coil bright annealing. Armstrong Insulation in these furnaces aids fast, accurate heating with economy.



...ong's Insu- Fire Brick of ...cial shape fit ...d tubes in the ...ilson furnaces on this page.

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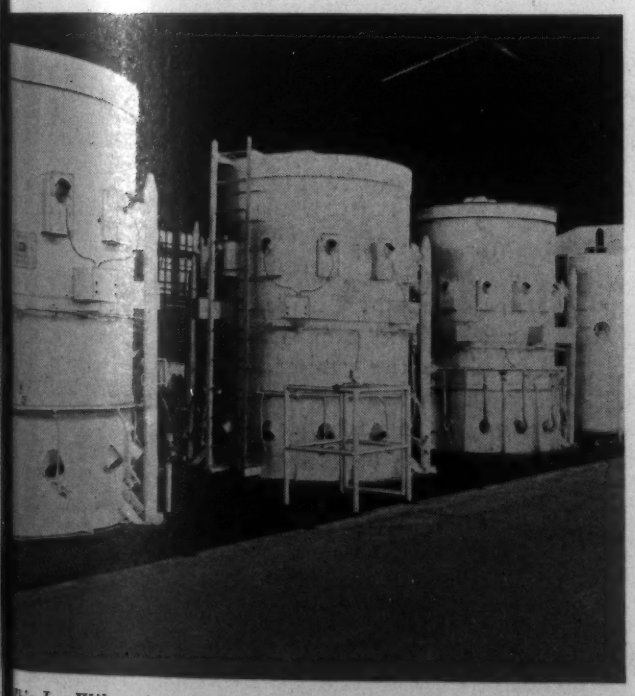

This Lee Wilson installation for Superior Steel Corporation includes ...ree furnaces and nine bases, for low carbon strip coil bright annealing.

...r the Townsend Company of New Brighton, Pa., Lee Wilson built ...e bell type furnace and four bases for low carbon wire annealing.

SHOWN on this page are several installations of cylindrical bell type furnaces and bases, built by Lee Wilson Engineering Company, of Cleveland, Ohio. Armstrong's Insulating Fire Brick in each of these jobs aid fast, efficient operation and uniform temperature control.

There are several reasons why this insulating material is selected by leading furnace builders. The use of Armstrong's Brick assures lower fuel costs, more accurate temperature control, and a faster operating cycle. In many types of furnaces, these brick permit thinner furnace walls and larger hearth areas. Their light weight offers many construction advantages which combine with space savings to aid investment reduction.

Armstrong's Insulating Fire Brick can be shaped as desired because they are strong and have a uniform, workable texture. The special shape shown fits accurately around tube inlets and outlets in the Wilson furnaces.

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Westinghouse Appoints Research Fellowships

Appointment of the second group of five Westinghouse Research Fellows has been announced by the Westinghouse Electric & Mfg. Co. The first group of five was appointed last year, and all of the group have been reappointed for a second year of fundamental research work at the company's research laboratories in East Pittsburgh.

These Fellows are named under a plan announced by the Westinghouse company in the fall of 1937, according to which 10 young research men will be supported for fundamental research in fields broadly related to the electrical industry. The new appointees are:

Dr. William A. Johnson, who will work on problems of diffusion of metals using artificial radio-active metals produced in the Westinghouse "Atom-masher" as tracers. He was graduated from Lehigh University with highest honors in metallurgy in 1935, and has just completed his graduate study in the Metals Research Laboratory of Carnegie Institute of Technology under Dr. R. F. Mehl. *Dr. Alois Langer*, who will work on chemical applications of artificial radio-active isotopes.

Dr. T. A. Read, who will study the processes governing internal friction in metals. Dr. Read comes from Columbia University, where he has been doing research in the energy dissipated in metals during vibration, in collaboration with Prof. S. L. Quimby and with Prof. C. Zener of the College of the City of New York. *Dr. Alden H. Ryan*, who will study the dielectric behavior of gases at ultra-high radio frequencies, corresponding to wavelengths of about ten centimeters. *Dr. G. L. Towney*, who will work on the fundamental processes of thermionic emission from oxide crystals, continuing basic studies in this field which he has been carrying on at Massachusetts Institute of Technology, where he has worked in collaboration with Prof. W. B. Nottingham.

The first group of five, whose reappointment for a second year was simultaneously announced, include three nuclear physicists, Drs. R. O. Haxby, W. E. Shoupp, and W. E. Stephens, who are working with Dr. W. H. Wells on the large atom smasher; Dr. J. A. Hipple, who has constructed a mass spectrograph for molecular structure studies; and Dr. Sidney Siegel, who is studying the effect of the order-disorder transition on the elastic properties of single crystals of copper-gold alloys.

Fellowship In Electrochemistry

The Electrochemical Society has just awarded the eleventh Weston Fellowship of $1,000 to Waldemar P. Ruemmler of St. Louis, Mo. Mr. Ruemmler will continue his research at Columbia University, investigating the electrodeposition of antimony, under the direction of Prof. Colin G. Fink. The Fellowship was founded by Dr. Edward Weston, a foremost pioneer in electrochemistry.

The Electrochemical Society also awarded to Nathaniel B. Nichols of Ann Arbor, Mich., The Society's Prize to Young Authors, for the paper published jointly by Dr. L. A. Matheson and Mr. Nichols entitled, "The Cathode Ray Oscillograph Applied to the Dropping Mercury Electrode." Mr. Nichols is a research associate at the University of Michigan.

Scaife Fellowship at Mellon Institute

The Wm. B. Scaife & Sons Co. of Pittsburgh has established an industrial fellowship in Mellon Institute for the purpose of conducting scientific research on problems pertaining to processes of fabricating and to the use of metal tanks, pressure cylinders, and water-softening equipment, its principal products. This investigational work will be in accordance with the company's desire to keep closely informed regarding all technical progress in its own and related fields, with special attention to present and probable future trade requirements, and to effect through research and development all possible improvements in its production practice as well as its products. For many years the company has carried on technical studies in its own organization, but the fellowship at Mellon Institute will enable the Scaife scientific staff to benefit by the investigational and cooperative facilities of the Institute

International Nickel Opens Sixth Field Service Office

A. J. Wadhams, vice-president of the International Nickel Co., Inc., and manager of the Development and Research Division, has announced the establishment of a new field office located at 67 Wall St., New York. The new office, which was opened May 1, is under the direction of J. W. Sands. Its main function will be to promote the use of nickel alloy steels and stimulate interest in products of the Huntington Mill, nickel cast irons and the use of nickel in non-ferrous alloys. The territory covered by this office includes Metropolitan New York, Long Island, New Jersey, Pennsylvania east of Williamsport, Harrisburg, York, Delaware, Maryland, Virginia, and the District of Columbia.

This is the sixth office opened by the Development and Research Division to give manufacturers in various industrial districts prompt, efficient service in handling their metallurgical problems. Other offices are located in Los Angeles, Calif.; Chicago; Detroit; Hartford, Conn., and Pittsburgh.

South African Meehanite Co.

Increased industrial activity in South Africa, accompanied by considerable expansion among iron and steel producers and by mining operators, has led the Meehanite Metal Corp., Pittsburgh, to establish a subsidiary company known as the South African Meehanite Metal Co. (Pty.) Ltd., Johannesburg, South Africa.

This company, organized to grant manufacturing rights for Meehanite Metal to South African concerns, has just installed Meehanite manufacturing processes in two companies in the Transvaal: The East Rand Engineering Co., Ltd., and Wright-Boag & Co., Ltd. The latter concern is said to be the largest general engineering company in the territory, manufacturing every type of mining equipment complete, from castings to finished machines.

Publications Adopting Standard Trim Sizes

As the result of a committee activity sponsored by the National Industrial Advertisers Association and undertaken by its Pittsburgh Chapter—Industrial Advertising Council—more than 30 trade and business publications have adopted the standard trim size of 8¾ in. by 11⅝ in. N.I.A.A.'s recommendation of this trim size was sent to 174 publications in the United States using a 7 x 10 in. type page but having a variety of trim sizes. It is expected that many more of this group will adopt the recommended standard as soon as they can arrange to do so. In Canada, several publications have already changed to the trim size recommended by the committee, and the entire subject is being considered by the two Canadian chapters of the N.I.A.A.

The use of this uniform trim size means a large saving in time as well as money for advertisers using bleed pages. Such advertisers can now use the same size art work and plates for an extensive list of publications previously requiring bleed plates of different sizes. It is also an added convenience to readers in filing magazines or clipped pages.

Streamlined Aluminum Trains

Two new streamlined aluminum trains, ordered for fall delivery by the Missouri Pacific railroad, will raise the nation's total of such trains to an even dozen, not counting trains built of other materials but having many aluminum applications throughout, says the Aluminum Co. of America.

The lightweight twin flyers will be used to provide a new high-speed passenger service between St. Louis, Kansas City and Omaha, the announcement says. The trains will be built by the American Car & Foundry Co. at its St. Charles, Mo., plant. Each will be pulled by a 2,000-horsepower Diesel-electric locomotive which have been ordered from the Electromotive Corp. at La Grange, Ill.

(Continued on page MA 386)

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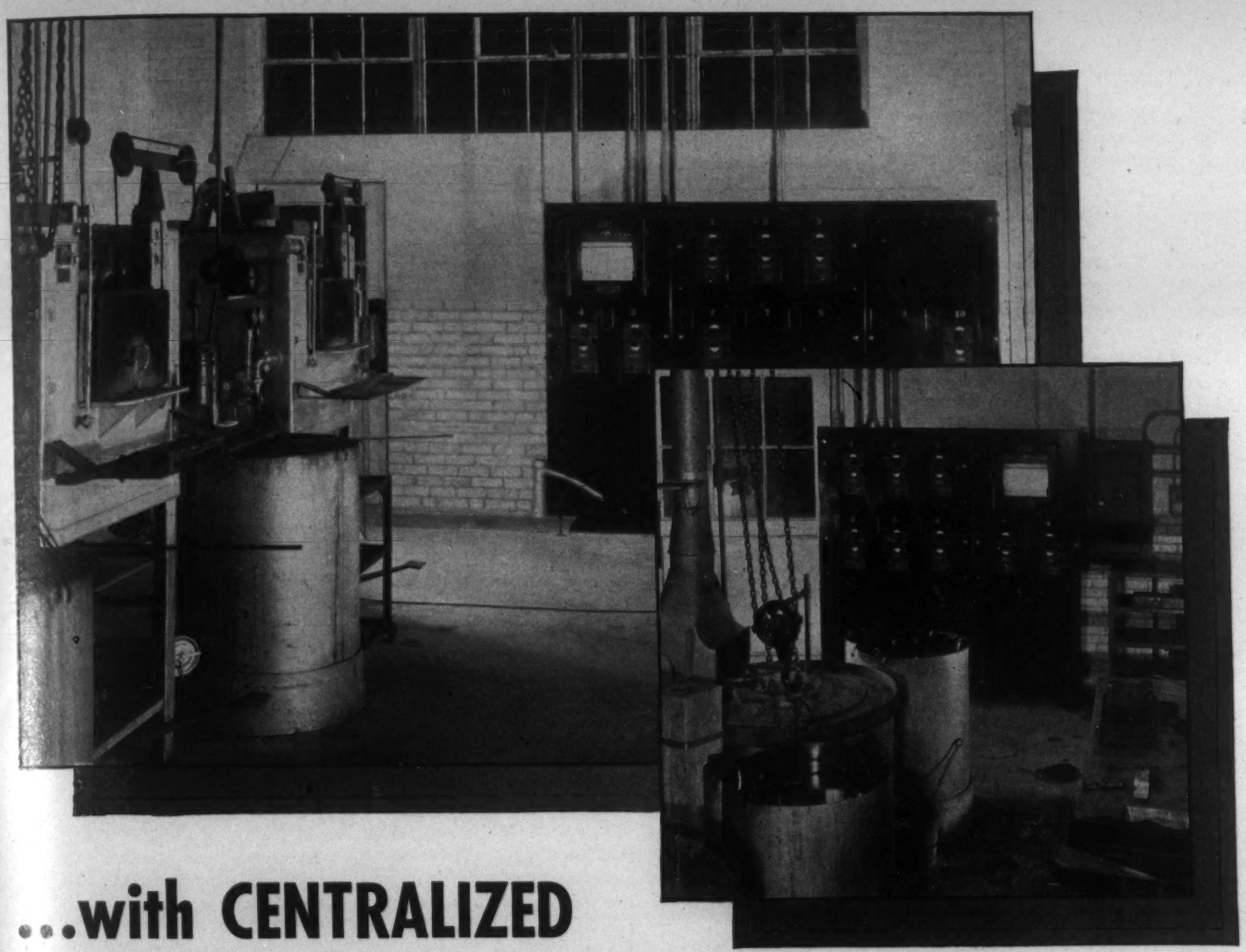

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Gold Plated Reflectors for Baking Enamel

Plating heat lamp reflectors with gold is one of the more surprising of the hundreds of diverse operations conducted within the 1096-acre Rouge plant of the Ford Motor Co. at Dearborn, Mich. The reflectors are used in electric ovens of new design which bake the paint on Ford and Mercury car bodies "from inside out."

The heat lamps, thousands of them, are arranged in tunnels, and the bodies travel through on overhead conveyors. The method is so efficient that the primer coat is baked in 15 mins. instead of the hour formerly required when steam ovens were used. This speed, Ford engineers who developed the method explain, is the result of using infra-red rays which penetrate the primer coat and heat the metal underneath. The heat then dries the primer coat rapidly from the inside. Gold plate was selected for the lamps because gold reflects infra-red rays with less loss than other surfaces. A little gold goes a long way in this electro-plating process. A piece of 24-karat gold 1/16 in. thick, 1½ in. sq. and weighing 45 grams is sufficient, in fact, to plate approximately 500 reflectors. The actual time of plating, once everything is in readiness, is only 50 seconds. Approximately 14,000 of the gold-plated heat lamps now are in use in the Rouge plant, and others are being made as application of this enamel baking method is extended. In order to keep the reflectors at top efficiency, about 200 are removed daily from the tunnel and replaced by spares while they are being cleaned or replated. The infra-red process was developed in the plant especially for baking Ford synthetic resin enamel, which retains its luster and color for the life of the car.

Six Million Silver Brazed Joints Without a Failure

A production record, recently released by the General Electric Co., tells of a remarkable service they are getting from low temperature brazing alloys in constructing transformers. More than 6,000,000 copper to copper joints have been made in the last few years and to date there has not been a single field failure. These joints are mainly between taps and coil conductors and between copper bars. Incandescent carbon heating is used principally in making them and the alloy, which is a silver, copper, phosphorus composition, is preplaced in strip form between the parts joined or, in some joints, is fed in from a rod by hand. Numerous tests have been made to determine the electrical conductivity of this type of joint. Lap joints show less resistance than the copper itself, while butt joints show a very slight amount more resistance.

New Electrode Plant at Niagara Falls, N. Y.

The Great Lakes Carbon Corp., recently organized under the laws of Delaware and controlled by the same interests as Great Lakes Coal & Coke Co. of Chicago, announces the immediate construction of a carbon electrode plant.

Amorphous carbon and graphite electrodes in all the commercial sizes will be manufactured at this plant to be erected at Niagara Falls, N. Y. Construction and operation will be under the direct supervision of B. E. Broadwell, formerly general manager of the Republic Carbon Corp. and a recognized leader in the industry.

The plant will be an extensive one of advanced design requiring several months for construction. It will be built on a 15-acre site just outside the Niagara Falls city limits and when completed will employ approximately 150 men.

● The Blaw-Knox Co., Pittsburgh, has received an order for equipment to be used in the construction of two new open-hearth furnaces at the plant of the Dominion Steel & Coal Corp., Sydney, Nova Scotia. The new furnaces will be built by Arthur G. McKee & Co., Cleveland, and will be of the tilting type with rated capacity at 250 tons. The order to Blaw-Knox includes the reversing valves complete with operating mechanisms and all water cooled doors and frames for the furnaces.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Metallurgical Engineer '36; age 24, 3 years of practical experience in a metallurgical laboratory; work consisting of metallography, development work, production difficulties, field troubles, etc., on a wide variety of metals. Now employed. Desires a position with a future. Excellent references. Box MA-139.

POSITION WANTED: Melter on Heroult Electric Furnace, 7 years' experience with tool, stainless and other alloy steels. Location no object. Box MA-140.

POSITION WANTED: Supervision. Industrial Metallurgical Engineer. 5 years sales; 2½ years sales promotion; 4 years industrial metallurgy; 2 years industrial process. Supervision—electroplating, ceramic, lubrication, chemistry and materials utilization; 2 years executive training. Capable, age 30, married, now employed. Box MA-141.

POSITION WANTED: Graduate chemical engineer, age 26, single. Three years of mechanical and metallurgical experience in the manufacture of cemented carbides and wire dies. Included eight months abroad setting up new plant and one year research in field of hard materials for dies or abrasives. Available on short notice. Box MA-142.

● T. E. Barlow has been appointed metallurgical engineer of the Copper, Iron and Steel Development Association, with headquarters at 5005 Superior Ave., Cleveland. He will act as technical service representative of the association of copper producers, whose aim is to direct the increasing tonnage of copper employed in iron and steel to the best possible advantage. Since 1936 Mr. Barlow has been a research engineer at Battelle Memorial Institute, where most of his work centered on the use of copper in cast iron, malleable iron, and steel. Previously, he was chief metallurgist of a large automotive jobbing foundry in Detroit. He is a graduate of the University of Michigan and is a member of the American Society for Metals and the American Foundrymen's Association.

● George Muscio, for the past 5 yrs. head of the research laboratory of The Lea Mfg. Co., Waterbury, Conn., has resigned to open a consulting laboratory at 480 Watertown Ave., Waterbury, Conn., serving the metal-working and allied trades. He will be retained by The Lea Mfg. Co. as consultant, co-operating with their research laboratory.

● Frank B. Conlon has joined the Sheffler-Gross Co., Philadelphia, as sales engineer. He was formerly with the engineering department of the Pennsylvania Railroad, headquarters in Philadelphia, and later with the Airtemp Corp. of Dayton, Ohio. He will specialize in sales and engineering with particular reference to air conditioning, heating and ventilating work.

● P. W. C. Strausser, who for 8½ yrs. has been research associate for the American Electroplaters Society at the National Bureau of Standards under the supervision of Dr. W. Blum, has resigned to accept a position with the Frederick B. Stevens, Inc., of Detroit. Mr. Strausser will take over the sales and servicing of their plating and equipment line of merchandise in the Detroit area. Before his assignment to Washington, he spent about 15 yrs. in Detroit having been connected with the Ford Motor Co., General Motors Corp., and the Chrysler Corp. and therefore has built up a wide acquaintance in the Michigan district.

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trends

By Edwin F. Cone, Editor

Metallurgical Observers

It is evident that the use of metallurgical observers in American steel plants is on the increase. The Bethlehem Steel Co. is generally credited with the first serious and general adoption of this practice. Testimony at the recent annual meeting of the open-hearth committee of the A.I.M.E. indicated that many plants are adopting this practice.

Research Expansion

The chairman of the board of one of the four largest steel producing companies of the country, in an address recently before a large technical society, made the following striking comparison in discussing research. In 1920, he said, there were approximately 500 research laboratories in the United States, employing 600 persons and spending $25,000,000. Today there are 1800 such laboratories with 32,000 employees with $200,000,000 involved.

Magnesium Gains

Magnesium is rapidly gaining importance as a metal in industry. The production (sales) of primary magnesium in the United States in 1938 was greater than ever before, says the U. S. Bureau of Mines. Last year's sales were about 6 per cent above 1937, the previous peak. The 1938 total was 4,819,617 lbs.

Vanadium Supplies Increase

Production of vanadium ores "increased phenomenally in 1938," according to the U. S. Bureau of Mines. American production is reported as 1,439,296 lbs. of contained V, an increase of about 42 per cent over 1937. Imports last year were 1,384,320 lbs. of contained V, a 10 per cent increase over 1937.

Beryllium at Lower Cost

One American company has reduced its price for beryllium. The Brush Beryllium Co. of Cleveland has announced an $8 reduction on beryllium copper to $15 per lb. of contained Be. This metal is slowly following in the footsteps of others which were expensive in their early history, such as aluminum.

New Record for "Moly"

The curve for molybdenum production continues its ascent. Data of the U. S. Bureau of Mines for 1938 show that the output in the United States established a new high—a 13 per cent increase over the record output for 1937. The 33,297,002 lbs. of contained Mo produced last year were almost double the 1936 total. About 85 per cent of the domestic output is credited to the Climax Molybdenum Co.

Steel—"Prince or Pauper"

A striking illustration of the trite saying that the steel industry is either "prince or pauper" is the financial record of nine of the leading American steel companies during the last two years. In 1937 each of these nine companies (all producers of over 1¼ million tons of rolled products per year) made a profit, the total for the year having been $195,724,581. In 1938 the profit of four of these companies was $17,321,230 and the loss of the other five was $23,600,511.

Expanding Aircraft Industry

A writer in *Steel* states that the American aircraft industry is rapidly attaining major proportions. More than 800 companies are now building aircraft or parts and the industry represents an investment of $75,000,000. In 1938 units were produced valued at $140,000,000 and this year's output is calculated to reach $200,000,000.

Sand Control

There is a marked trend in the foundry industry toward incorporating testing equipment to enable the personnel to control the purchase and processing of materials used—particularly in controlling exactly the physical properties of molding materials. This trend is pointed to by H. W. Dietert as doing much to place castings in the preferred list for machine parts. Future work in advancing sand and core testing will be largely in high temperature testing, which should result in the development of better molding materials.

Air-Conditioning the Blast Furnace

Blast furnace men are watching with keen interest the experiments on air-conditioning the air for the furnaces at one of the plants in the south. One of the problems involved is the regulation of the moisture—always an important factor due to changes in the weather.

Taxes per Ton of Steel

The trend in taxes on steel is decidedly upward. The American Iron and Steel Institute says that for every ton of finished steel made in 1938, the steel industry paid $5.18 in taxes, or 78 per cent more than in 1929 when it was $2.91 per ton. In 1937 the taxes were $4.96 per ton.

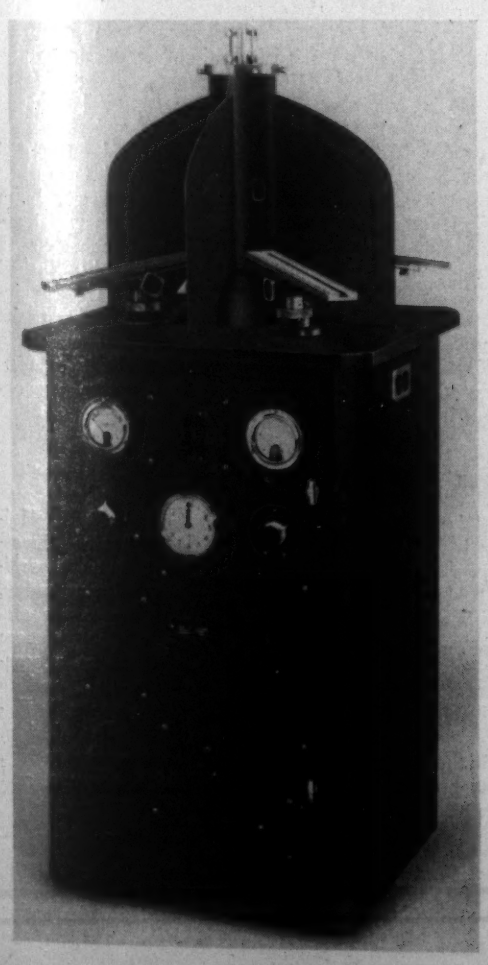
O-H Slag in the Blast Furnace

The trend is towards the greater use of open-hearth slags as part of the burden of the blast furnace. The chief factor involved is the recovery in the pig iron of a large part of the manganese in the slag. More and more is manganese-bearing pig iron considered vital in producing quality steel, whether acid or basic open-hearth.

New Equipment and Materials

X-Ray Diffraction Unit

A new X-ray diffraction unit, claimed smaller and more versatile than previously available outfits of this type, has been announced by the General Electric X-Ray Corp., Chicago. Complete, with newly designed cameras and other accessory devices which provide for its ready application to chemical and metallurgical analysis and testing, as well as to other branches of industrial science, the "G-E XRD" unit, as it is called, is somewhat lower in price than the large apparatus which it has been designed to replace.



Precision-built to produce patterns with a high degree of accuracy, and ruggedly constructed to withstand the constant use common to industrial laboratories, the XRD unit also incorporates new features of design which simplify operation to the extent that the scientist may have more free time for the preparation of specimens and for better organizing his test routines.

It is described as entirely shockproof, and provides for the use of a variety of X-ray tubes having target materials best suited to the various applications to which it may be put.

Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts not more than 2 in. wide.

Continuous Wire Annealing In a Gas Flame

New tricks making possible the continuous annealing of single strands of copper wire while racing through open gas flames at rates up to 1,000 ft. per min. promise to "help to do away with long tedious annealing cycles in bulk," according to W. M. Hepburn, vice-president and chief engineer, Surface Combustion Corp., Toledo, who announces a test run of 10 to 20,000 lbs. of wire just begun through new equipment developed jointly by his company and the Syncro Machine Co., Newark, N. J.

Essentially the apparatus consists of a long row of extremely accurately controlled gas flames—with positioning dies spaced along the length of the row so that the wire passes through just that portion of each flame in which combustion has advanced to the point where both temperatures and burning gas compositions are "just right" for the anneal. Adjustment is provided by the height and character of the flames as well as by the speed of the wire along its flaming route. The unit now in operation uses a line of special gas jets 9 ft. long, although it is planned to boost this length to 27 ft. and step up wire velocities accordingly. The result will be multiplied production.

The mechanism for the spooling and unspooling of wire is understood to be quite ingenious. Further, all equipment is automatically regulated by the resultant anneal through a continuous, indicating "anneal meter" at the finish end of the unit. This gadget, according to reports, functions to "feel" the "texture" of the wire surface as it leaves the annealing burner.

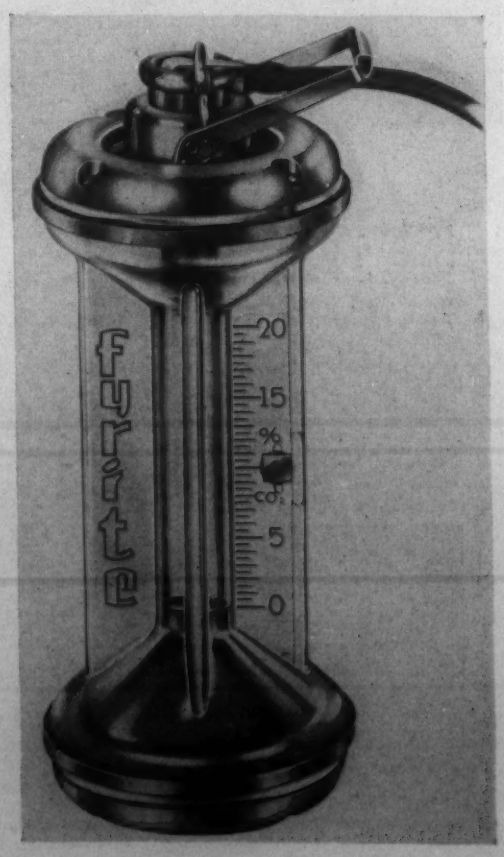
Another dollar-saving virtue of the new apparatus, it is claimed, is that it results in a more uniform anneal than is attainable in batch and even many continuous operations. The general previous practice has been to anneal the wire in spools, necessitating a rather carefully controlled soaking period to produce uniform results from the surface to the core of the spool.

How widely continuous open-flame annealing will be applicable in wire mills cannot be predicted at this sitting, but it is expected to save considerably in equipment, maintenance, space, and time wherever the process is found practicable.

Pocket Size CO_2 Indicator

The Bacharach Industrial Instrument Co., Pittsburgh, has announced a new pocket-size CO_2 indicator, trade-named "Fyrite". It is said to be practically non-breakable, accurate, inexpensive, and easy and quick to operate.

An entirely new principle is said to make the Fyrite unique in simplicity of use and fool-proof operation. There are no valves, clamps, nor leveling bottle to manipulate. A complete analysis takes less than 20 sec. It is distinctively styled from crystal-clear plastic material. Its operation is claimed extremely simple. A dozen strokes of the aspirator bulb fills the Fyrite gas chamber with the flue gas to be analyzed. The sampling hose is then attached which automatically seals the Fyrite and makes it ready for the analysis. To mix the gas with the absorption fluid, the Fyrite is turned upside down, then back again to its normal position. This takes about 10 sec. The suction created, due to the complete absorption of the CO_2, pulls the absorbing fluid up in the graduated tube an amount equal to the CO_2 absorbed. Consequently, its level shows the percentage of CO_2 in the gas. The entire operation, including the pumping of the gas, takes less than 1 min. As received it is ready for immediate use. The absorbing fluid is good for several hundred readings before it needs replacement.



"Rexalloy"—A Cast Tool

The Crucible Steel Co. of America, New York, announces a cast non-ferrous alloy with the trade name "Rexalloy". Its basic elements are cobalt, tungsten and chromium. It is claimed that it may be used on practically all machining operations and on all types of machine tool equipment. Its hardness and structural stability at extreme temperatures are indicated by the fact that only a one point drop in hardness on the Rockwell C scale is occasioned after exposure to 2,000 deg. F. Available in tool bit form, the new alloy is said to possess greater resistance to abrasive wear and to be tougher than cast tool material previously available. Proper grinding can be accomplished with ordinary tool room equipment. Tool cutting angles, customarily applicable for high-speed tool bits, can be used. Standard sizes range from ¼ in. sq. by 2⅛ in. long to ¾ in. sq. by 5 in. long. Rexalloy is also available in other than standard lengths and in many square and rectangular shapes.

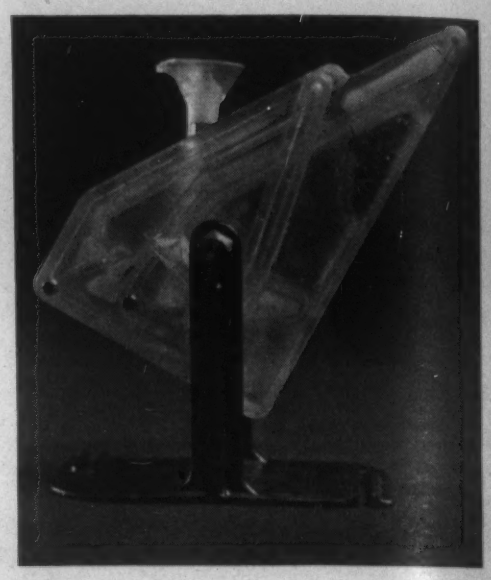
A Castable Refractory

A new ceramic material—"Alsimag 222"—is offered by the American Lava Corp., Chattanooga, Tenn. It is claimed to have the outstanding property that it can be machined after it has acquired strength by being fired. This is said to make it an ideal material for inventors, research men, and development engineers who frequently have to build working models and do not want to go into the initial expense of costly dies for sample work. They can do their experimental work on machined insulators made of Alsimag 222 and, after having established the shape and size required, the final product can be substituted by another Alsimag material most suitable for the specific purpose. The ability of the experimenter to do his own model work gives him best protection for patentable ideas.

Alsimag 222 is a porous material of good mechanical strength. It can be turned on a lathe or milled like steel.

Improved Automatic Flue Gas Analyzer

The Hays Corp., of Michigan City, Ind., announces a new design in its "Orsatomat", the automatic Orsat or flue gas analyzer. The greatest change is in the tilting analyzing unit which is now composed of a transparent plastic instead of hard rubber as formerly. The new unit is smaller, lighter in weight and more compact. It is housed in a newly designed streamlined, pressed steel case along with a draft measuring and indicating unit. Both analyzing and indicating units are removable. If desired, a flue



gas thermometer may also be had to fit inside the case.

The Orsatomat is a true Orsat as it employs the principle of volumetric measurement and chemical absorption. And the measuring and absorption of CO_2 is done automatically through an ingenious use of mercury. All that the operator needs to do to obtain an accurate analysis of a sample of combustion gas is to pull out a small rod that protrudes from the side of the case, aspirate the gas into the unit by means of a rubber bulb and push in the rod—the percentage of CO_2 is instantly indicated on a dial at the front of the case. As the rod is pushed down it tilts the pivoted unit causing a column of mercury to flow by gravity to push the trapped gas sample into the absorption chamber (a steel-wool packed compartment freshly flushed with absorbing chemical) where the CO_2 is instantly absorbed. This absorption causes the sample to shrink creating a vacuum which is effective on a sensitive metallic bellows connected to the dial pointer. The entire process requires about ½ min.

A Modulating Gas Valve

The Wheelco Instruments Co., 1929 S. Halsted St., Chicago, offers the "Wheelco Throttling Gas Valve." It is described as a self-actuated temperature controlled modulating valve, with a sensitive fill remote bulb temperature element, a complete temperature control system in a single unit, designed to operate as a combination "On-off" and throttling control, and to eliminate all possibility of "blow-backs." Extreme simplicity is the keyote of its design, which, together with superior workmanship, guarantees long dependable service, low cost and simplicity of installation.

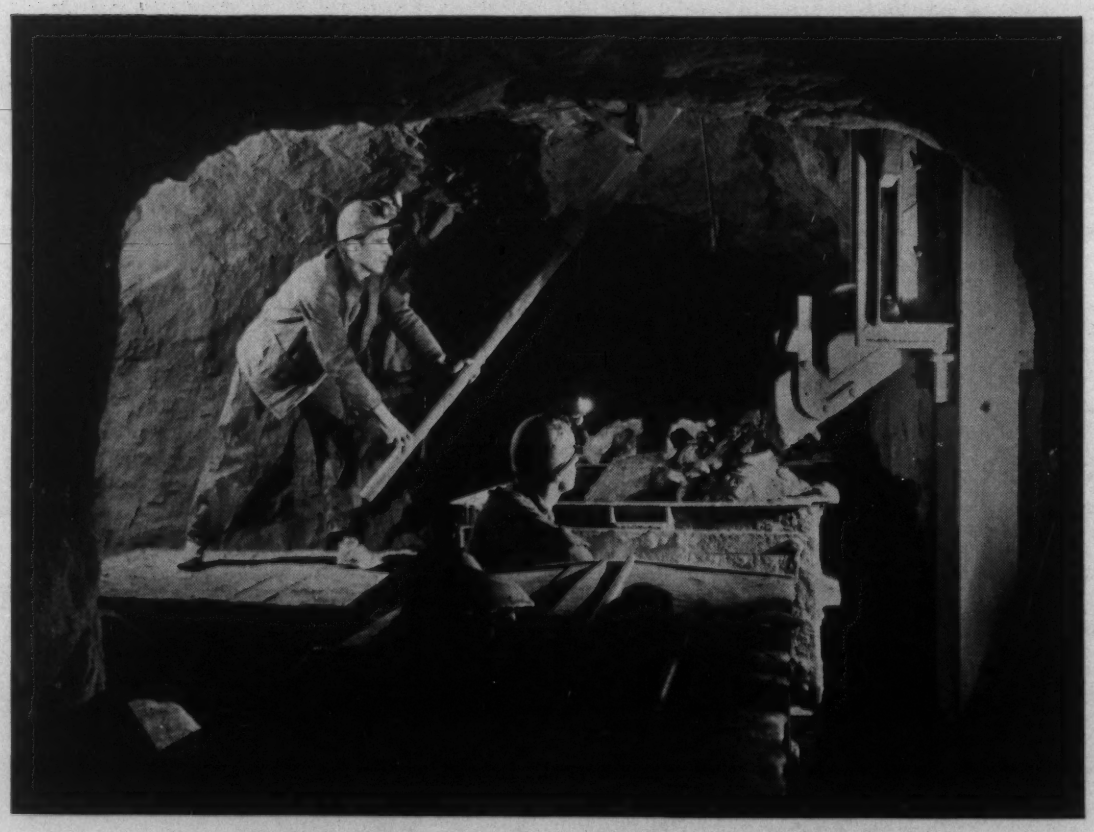
Line of Stainless Electrodes

A complete line of stainless steel electrodes covering all chemical analyses—claimed by the manufacturer to be an advancement in uniform, high-quality weld deposits—is offered by The McKay Company, Pittsburgh.

These electrodes are known as "McKay Certified Stainless Electrodes" and the makers state that each package contains a certification of weld deposit analysis rather than the wire analysis which has been the practice of manufacturers in the past. Further claims for superiority are as follows: (1) Instant contact upon restriking arc; (2) Maximum ease of slag removal; (3) Spatter free within practical limits; (4) Exceptionally smooth bead with perfect weld contour; and (5) All alloys contained in core wire.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 5 of a Series



LOADING THE ORE TRAINS

From every underground ore chute in the Balmat mine of the St. Joseph Lead Company the broken rock is drawn off into the ore cars. Each train of about ten 3-ton cars is drawn by a 7-ton electric storage battery locomotive. These trains rumble through the long haulage drifts that are cut in the solid rock below the stopes, for a mile more or less, and dump the ore into the underground ore pockets from which it is later drawn off into 8-ton capacity hoisting skips and hoisted 2,000 feet up the inclined shaft to the crushers on the surface.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE • NEW YORK
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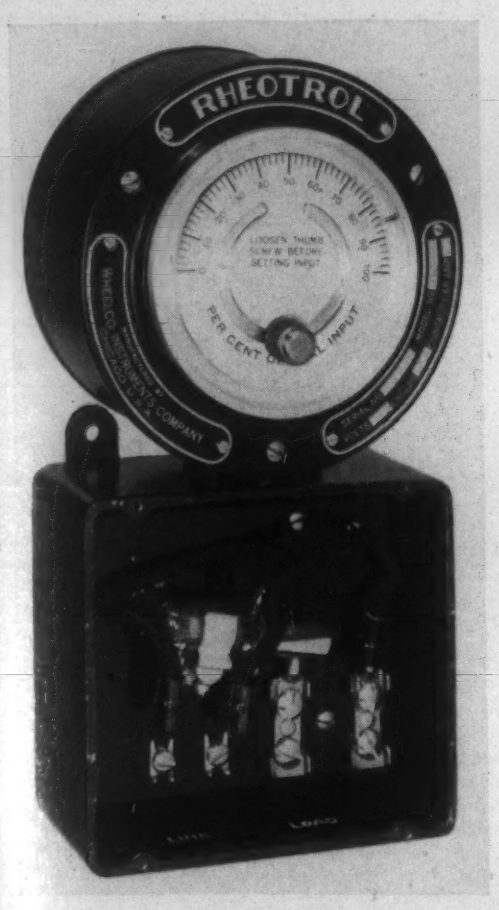
PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

The Wheelco "Rheotrol"

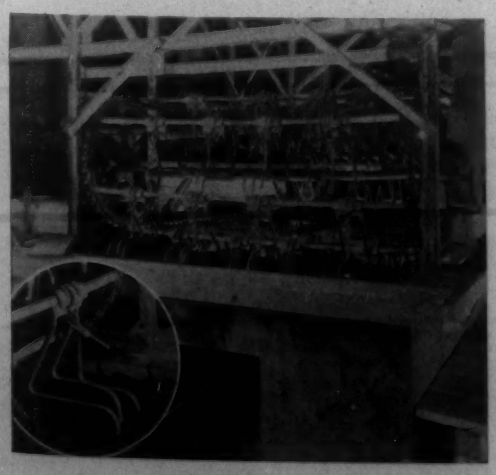
The Wheelco Instruments Co., 1929 S. Halsted St., Chicago, has put on the market the "Wheelco Rheotrol." It is described as a wasteless, stepless and highly efficient manual control for electrically operated furnaces, ovens, heaters, kilns, etc. The Wheelco Rheotrol is claimed to replace and far exceed the performance of the standard rheostat, eliminating current waste through resistors, thereby effecting a considerable saving in power consumption. The elimination of the step control, common to the rheostat, places any temperature in the furnace range at the command of the operator.



Koroseal Lined Tank

One of the most important applications for Koroseal, the synthetic rubber-like material developed by The B. F. Goodrich Co., Akron, Ohio, is as a lining for tanks used in stainless steel pickling. The unit shown in the illustration is used for pickling stainless steel beer barrels. It consists of a welded steel tank with a Koroseal lining which is protected against physical and thermal damage by a carbon brick sheathing. The solution handled is a mixture of 1 to 2% hydrofluoric and 15 to 20% nitric acids at a temperature of 165 deg. F. The tank is 17 ft. 4 in. long, 7 ft. 11 in. wide, and 3 ft. 9 in. deep.

In addition to being used as a lining material, Koroseal, in the form of tubing, is placed over the conveyor hooks to protect them against corrosion.



Hydraulic Testing Machine

For firms and institutions with limited funds to spend on testing equipment, the Tinius Olsen Testing Machine Co. of Philadelphia announces a moderately priced, compact "L-Type Hydraulic Testing Machine." This machine has a capacity of 20,000 to 60,000 lbs.—yet its overall height is but 63½ in., occupies only 10 sq. ft. of floor space, and has an approximate net weight of 2,000 lbs.

In design and construction, the manufacturer states, the machine boasts many advanced features. A moving piston supplies the necessary testing strain. The gear pump is the direct-connected type with a constant operating speed which, when the load is applied, produces no measurable pulsation. Testing speeds range from 0 to 2 in. per minute in stepless intervals, the control of which is a pilot handwheel 8 in. in dia. A separate pilot is furnished, with an additional valve, for holding or removing load.

An important feature is that the piston and cylinder require no packing, being ground to the most rigid tolerances. Any slight leakage is compensated for by the oil used in the loading system, which forms a seal between piston and cylinder. Friction is reduced to the minimum therefore, and the load is weighed within the close limits set by A.S.T.M. specifications.

The 15-in. crosshead adjustment is obtained through a crank convenient to the operator's hand. The compact and positive arrangement for opening and closing grips is provided by the enclosure of all gripping mechanism. The indicating gages are isolated from the machine proper by locating them on a separate instrument panel. Location of the cylinder itself in the base serves to lower the machine's center of gravity. Loading and unloading is performed through separate controls for each of these operations. The exceptionally sturdy oil reservoir bolted to the base of the machine serves as a support for the motor and pump, which are direct-connected by means of a flexible coupling, eliminating noise and slippage of the drive, whether chain or belt.

The new machine is fully described, along with illustrations and tables, in a recently printed folder, which may be had from the manufacturer.

HARLEY-DAVIDSON and HEVI DUTY furnaces

In the production of their internationally famous motorcycles, Harley-Davidson carburize many of the important cycle parts to increase their strength and wearing qualities. For this heat treatment they use Electric Vertical Retort Furnaces. These Hevi Duty Carburizers are noted for their consistent production of controlled uniform cases and economy of operation.

Write for Bulletin HD 937

HEVI DUTY ELECTRIC COMPANY

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MILWAUKEE, WISCONSIN

"Glyptal Gray" and Corrosion of Lap Welds

"Glyptal 1294 Gray", a recent addition to General Electric's line of welding accessories, was developed to meet the need of fabricators for a material which, when applied to metal to be lap welded, would prevent corrosion at the point where the plates overlap. It is a pigmented version of the previously announced Glyptal 1294 Clear and will, like the latter, prevent the adhesion of weld spatter when applied to parts before welding, it is said. On lap welds it will prevent corrosion at the overlap. At the same time it serves as an excellent base for painting.

Glyptal Gray can be sprayed or brushed and the work can be left exposed to the atmosphere until fabrication is complete with the assurance that edges on the parts will not need cleaning before the final welding operation.

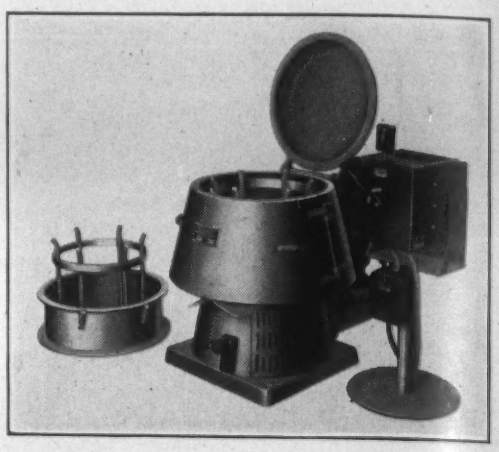
Special Apparatus for Chemical Analyses

The "Electropode" has been developed by the Fisher Scientific Co., Forbes St., Pittsburgh, for qualitative and quantitative analyses in organic or inorganic chemistry. Its operation is said to be based on two facts: When dropping mercury electrode is employed, an ion in solution makes its presence known by a current increase which takes place at a definite voltage; and there is a definite relationship between the amount of current increase at that voltage and the concentration of the ion causing that current increase. The unit has been used for determination of copper, lead and cadmium in commercial zinc; copper, nickel and cobalt in steels, etc. Only a small amount of low concentration of solution is necessary, and extensive analytical work having been conducted with as little as 0.005 cc. of solution.

Tolhurst Centrifugal Galvanizer

The use of the newly designed "Tolhurst Centrifugal Galvanizer" is said to secure a more even finish for hot tinned and galvanized articles. Bolts, nuts, threaded pieces, stampings, all kinds of hardware, castings and fittings are handled quickly and the metal coatings obtained are claimed free from hangings and lumps—threads and fine perforations are produced clean and clear. In fact, in many cases, articles hitherto impossible to hot dip successfully are now pointed to as beautifully coated in this manner.

The machine consists essentially of the removable basket and retaining cage, which is mounted within the casing. The basket, also used as a container for the work, is carried through the hot metal bath in the usual man-



ner and then placed in the Centrifugal Galvanizer and rotated. The centrifugal force of the turning basket throws off the excess spelter, leaving an even layer of metal with a high quality finish. The thickness of the coating is controlled by the acceleration of the machine and final speed attained.

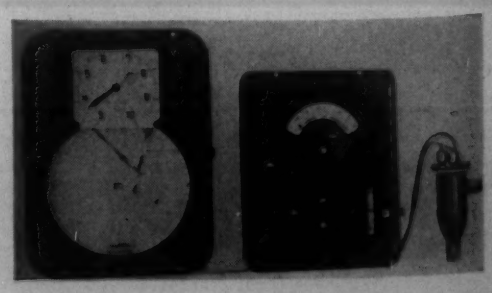
Motors are provided with variable speed and acceleration, so that all types of materials may be processed with equal ease. The casing is equipped with hinged sides for the easy recovery of slingings, which are returned to the melting kettle.

The new Tolhurst Centrifugal Galvanizer is built in three sizes, the largest of which is capable of handling articles up to 24 in. in length. Rated load capacity is 100 lbs. and 60 to 75 loads per hr. are obtainable. The new folder describing this machine may be obtained by writing to Tolhurst Centrifugal Div., American Machine & Metals, Inc., 100 Sixth Ave., New York.

New Line of pH Recording and Controlling Instruments

A new line of pH Recorders and Controllers has just been announced by The Bristol Co., Waterbury, Conn. These instruments employ the glass electrode method of measurement and are designed especially for industrial plant use. They are offered in two general types: Wide strip-chart model and the round-chart model. Automatic controllers are offered in both electric and air-operated models. The instrument can be plugged into any standard light circuit, fluctuations in the line voltage being automatically compensated for. Shielded glass and calomel electrodes are used for measurement and control.

Two types of electrode assemblies are offered: (1) The Enclosed Flow Type (solution under measurement is pumped or allowed to flow through the chamber) and (2) Immersion Type (designed for immersion in tanks and vats). They are of a size that is convenient to handle and are rugged enough so as to require no special handling precautions. They can be used in viscous or even semi-solid substances and in rapidly circulating or flowing liquids. Temperature changes are automatically compensated for.



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A Salt Tablet Dispenser

A new type of dispenser for supplying workers exposed to high temperatures with salt (sodium chloride) tablets to prevent heat sickness is announced by the Davis Emergency Equipment Co., 55 Van Dam St., New York. This new "Davis Salt Tablet Dispenser" is made of black plastic, which is chemically inert to salt. When a knob at the bottom is turned in either direction, a single tablet is dropped into the palm of the hand. It is mounted near the drinking fountain so that workers can take the tablets with their drinking water. There are two sizes, one holding 1,000 tablets and one holding 500. The smaller size is suitable for mounting on a truck serving field workers or for use in small establishments. For the individual use of field workers, booklets containing 6 tablets, individually wrapped in cellophane are supplied.

Salt is needed by men working in temperatures above 90 deg. F., either indoors or out of doors, because depletion of the body salt through excessive perspiration may cause heat sickness, which is characterized by cramps, nausea, dizziness, and general muscular exhaustion. From 4 to 6 10-grain salt tablets a day should be taken to replace the lost body salt.

Meehanite in Redesigned Crankshaft Lapping Machine

Complete redesign of a crankshaft lapping machine, utilizing new materials and eliminating all hand operations by means of hydraulic action and push button control, is announced by A. P. Schraner & Co., Cleveland. The machine, known as Model B, laps all main and throw crankshaft bearings simultaneously, producing a mirror finish. Adaptations may be made to include the side walls of thrust bearings and, if desired, oil slinger grooves.

The hydraulic operating arrangement permits increased rotating speeds as well as higher abrasive pressure and accurate control of the pressure of the abrasive against the work.

A feature of the new design is the adaptation of Meehanite castings to vital parts such as real support brackets, rail, hydraulic tail-stock cylinder and casing, head-stock, head raising cylinders, and the work head guides which are hardened. Previously, work head guides required a riveted construction. The new single castings adopted for these parts have been found to provide better operating efficiency and considerably longer life.

Arrangement of the abrasive paper attachments includes automatic feeding of new and removing used paper. By this arrangement, each crankshaft is lapped under uniform conditions, which provide uniform results and continuous production. Each bearing is perfectly finished to the extreme ends and, if required, adjustments may be made to include the fillets. From 45 to 60 shafts per hr. may be finished.

Welding Point Puller

A simple taper point-puller for hydromatic and multiple spot welders is now being offered by the Progressive Welder Co., Detroit. Features of the puller are: Automatic locking—no slipping or scoring of the electrode; positive grip; instantaneous operation; straight-line pulling action; and light weight.

The design of the puller is such as to eliminate damaging of the welding point seats. The puller jaws are slipped over the electrode, a slight lift of the handle seats the jaws, and a tap of a hammer on the bottom of the puller removes the electrode from the holder.

Bell-mouthing of the electrode socket is avoided by designing the puller so that it will be self-aligning in action. Even if the puller be inserted at an angle, or the blow struck at an angle with the hammer—the pulling action will be in line with the axis of the welding point.

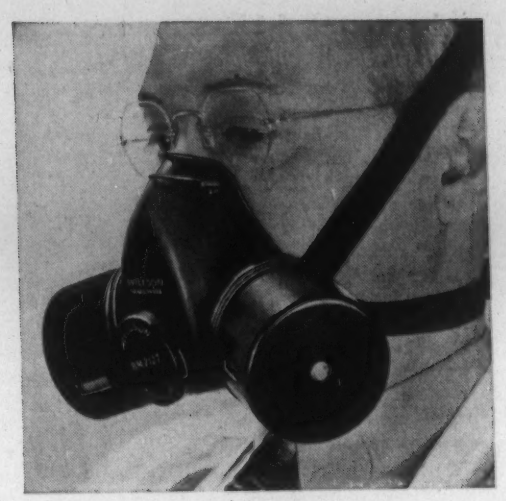
Shocks are absorbed largely within the puller affording additional protection to the welder, yet the leverage is such as to insure easy removal, it is claimed, of the most tightly seated welding points. The pullers are available in sizes to take care of points with Morse No. 1, No. 2, or No. 3 taper.

A Filter Respirator

Willson Products, Inc., 269 Thorn St., Reading, Pa., has announced a new low-resistance twin filter respirator for protection against both Type A and lead dusts. It bears Bureau of Mines approval No. 2127 and is the tenth Willson respirator to be officially approved by this Federal agency under Schedule No. 21.

This respirator, designated as No. 752L, employs a small rubber, form-fitting face piece so designed as to permit the wearing of goggles or spectacles without visual interference. Two Rotiform Filters, each with 30 sq. in. filtering surface, minimize breathing resistance.

The manufacturer will gladly furnish complete information, descriptive literature and prices upon request.



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Water-Cooled Skimmer Bar

The Chicago Mfg. & Distributing Co., Chicago, which produces an extensive line of slag skimming equipment, has recently developed a water-cooled skimmer bar. This skimming bar is primarily intended for the use of skimming slag off molten metal in the process of melting ferrous and non-ferrous metals and other materials.

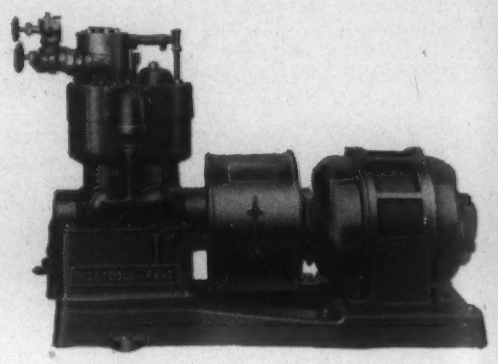
The new "CM&D Water Cooled Skimmer Bar" is so designed that any type of accessory can be attached, such as the skimming blade, for manipulating molten metal without difficulty. The tendency of the bar sagging or melting from intense heat is completely eliminated. The bar itself is so designed as to give longer service without any maintenance. The only replacement required, or expense involved, is the attachment such as a skimming blade, spoons, ladle bowls or agitating stick head. This replacement, however, is only necessary after

considerable use. It is manufactured in any length desired. The attached head is made of high heat resisting steel alloy castings. The anulus is made up of seamless steel tubing. The entire assembly is welded with high heat resisting welding wire.

The function of the CM&D Water Cooled Skimmer Bar is to introduce water through the outer anulus and is forced to circulate to the extreme end of the skimming head through the special designed baffles, in order to relieve any back pressures that might occur during the flow of the liquid; also to relieve the discharge of liquid through the center anulus.

High Pressure Starting-Air Compressor

Type 20 vertical, stationary, two-stage, high pressure air compressors for starting internal-combustion engines are the subject of an illustrated description leaflet just published by Ingersoll-Rand. These machines are built in four sizes ranging from 7½ to 20 h.p. for piston displacements of from 29 to 60 cu. ft. per min. at discharge pressures of 300 to 400 lb. on heavy-duty service, and up to 1000 lb. on intermittent starting service. They are available in a variety of drives which include direct connection

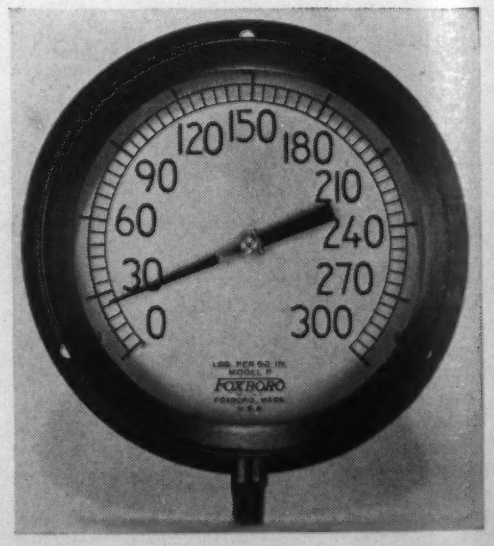


to electric motor, gasoline or oil engine, and flat or V belt.

The Type 20 compressor is water cooled, automatically lubricated, and requires a minimum of attention. It is particularly adaptable for use in starting stationary and marine Diesel engines, as well as for supplying small quantities of high pressure air for industrial applications.

Pressure Gage

Chrome-molybdenum steel is used in the bourbon spring in this all-welded steel model P pressure gage, offered by the Foxboro Co., Foxboro, Mass. A special Chapmanized steel is employed in the pinion, segment, arbor and connecting link. Segments and pinions have milled teeth. Many other parts, including the pointers and dials are of stainless steel. Model P test gage is available in ranges from 0 to 15 lbs. up to 0 to 10,000 lbs., guaranteed accurate within ½ per cent. Model P hydraulic gage, in ranges up to 600 and 1000 lb., is guaranteed accurate within 1 per cent at any point on the range.



A Solid Paint

The Markal Co., 6 E. Lake St., Chicago, offers a solidified paint in stick form for marking metals, hot or cold. It is called "Markal" and is supplied in two types, one for cold marking, and one for hot marking. The latter is suitable for temperatures from 200 to 1800 deg. F. and it is claimed that the material will not run, charr nor discolor, nor will it peel off or crack when the material cools. Acid pickling baths will not disturb the marking. It comes in black, white, yellow, green, red and blue in packages of 36 sticks, with hardwood holder. Markal sticks for cold work come in the same colors, in packages of 12, with metal holder.

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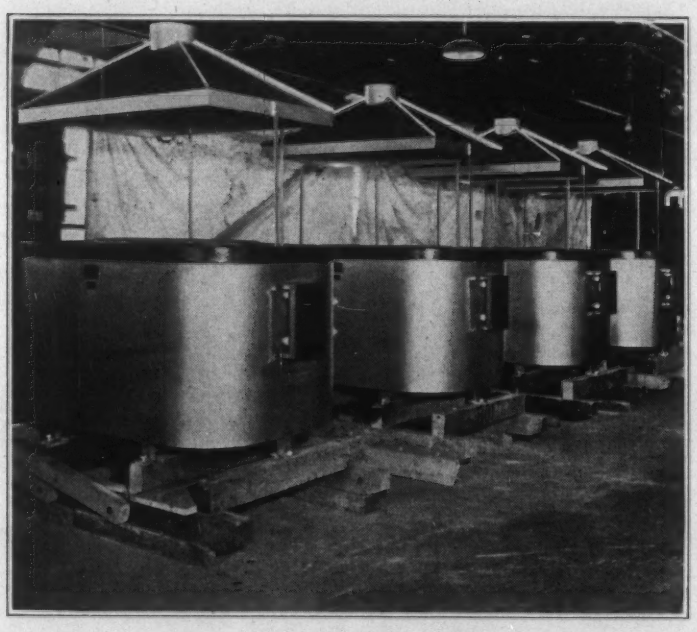
RECTANGULAR POT FURNACES

for

Lead - Salt - Cyanide - Liquid Nitriding



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JULY, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

1 Ore Concentration

Crushing, Grinding, Plant Handling, Gravity Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching

JOHN ATTWOOD, SECTION EDITOR

Improvements in Crushing and Grinding Practice. C. T. OUGHTRED. *Mining Congr. J.*, Vol. 25, Jan. 1939, pp. 21-25. Descriptive. Mills up to 50 tons daily capacity use small jaw crushers only; in plants from 50 to 250 tons, gyratory crushers follow the jaw crushers; in plants over 250 tons, jaw or large gyratory crushers followed by cone crushers or rolls in closed circuit are used. Close attention must be given to screening in order to attain maximum capacity. Orientation of screen openings is also an important factor. Most common practice is to place the long dimension parallel to the flow. Alloy steels are widely used for wearing parts. Closed circuit grinding is a well-established practice. Rod mills should run with lower circulating load than ball mills. Rod mills do not necessarily have to be longer than their diameter. Ball mills have almost universal acceptance for fine grinding. Most operators consider 400-600% circulating load the best operating range. Most efficient mill operations indicate a speed of 73-75% of critical. Cast Fe balls usually show a decided saving in grinding cost. However, forged balls are in favor in sizes above 4 in. diameter. Mn steel liners are used in coarse grinding, hard cast Fe or alloyed Fe in finer grinding. The classifiers are the weakest link in the grinding process. No important improvements have been made in these in recent years, except in their mechanical construction. New Hadsel mill at Trail is described. BHS (1)

Pneumatic Conveying at Giesche Spolka Akcyjna, Poland. ROY E. THOMAS. *Metals Tech.*, Vol. 6, Feb. 1939, T.P. 1045, 11 pp. Descriptive. Soon after the Waelz plant for the fire concentration of low-grade Zn ores was put in operation in the early part of 1929 at Katowice, it was found that the conveying equipment for transporting the hot residue from the furnace dust chambers was inadequate. Hand tramming with water cooling was used for a time, but that method was injurious to the workmen as well as costly. The problem was to find some practical mechanical method of conveying flue dust at temperatures of from 450° to 600° C. as it was drawn from the dust chambers. After considerable preliminary investigation it was decided to install pneumatic equipment for conveying the hot materials to a central mixing plant, where it would be mixed with slime and from which it could be returned to the furnace feed hoppers. The equipment is described in detail. JLG (1)

Ore Concentration and Gold Milling. E. W. ENGLEMANN. *Mining & Met.*, Vol. 20, Jan. 1939, pp. 13-16. Progress report for the past year, covering flotation machines and reagents, by-product recovery, alkalinity control, conveyors and electric ears. Rapid progress in Cu mills has been made throughout the country. Flotation reagents have remained the same, with the exception of "Minerec A" in Pb and Zn concentration. Also, 4 new American Cyanamid reagents are being used, known as Nos. 645, 632, 610 and 637. In Au and Ag ore treatment, use is being made of combination processes. A device being used in dry and wet bar mill grinding in open and closed circuits is the "Hardinge electric ear." VSP (1)

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

A. H. EMERY, SECTION EDITOR

Metallurgical Use of Anhydrous Chlorides, their Production and Properties (Hüttenmännische Verwendung wasserfreier Chloride, ihre Herstellung und Eigenschaften) W. KROLL. *Metall u. Erz*, Vol. 36, No. 4, 1939, pp. 101-106; No. 5, 1939, pp. 125-131. Correlated abstract. Many metallurgical uses of chlorides are listed. A classification of them is made on the basis of their heats of formation. Chlorides of Si, B, Zn, Sn, Al, Co, Ni and Cr can be used to coat Fe with these elements, while Cu can be plated using chlorides of Si, Sn, Cr or Al. The possibility of removing impurities from the base metals Al, Pb, Sn, Bi, Au, Zn, Ag, Sb, Fe, Mg and Cu using Cl_2 or chlorides of the base metals is summarized in a table. Impurities are classified according to their removal as "Possible," "Impossible" and "In Equilibrium." The physical properties are discussed, and the boiling and melting points of many of the chlorides tabulated. The variations in properties of the chlorides often permit separation or treatment of the metals based on these differences. The loosely held Cl_2 atom in some chlorides makes them useful as Cl_2 carriers or by replacement with O_2, they can be changed to oxychlorides. The metallurgical aspects of the replacement of O_2, S or C in oxides, sulphides and carbides with Cl_2 is discussed. The production of alkali or alkaline earth metal alloys of Pb, Zn and Sn using CaC_2 and chlorides is considered. A laboratory apparatus for the production of anhydrous chlorides is described. 70 references. PCR (2)

2a. Ferrous

Design and Operation of a Modern Blast Furnace. J. C. BARRETT. *Iron Steel Engr.*, Vol. 16, Feb. 1939, pp. 17-30. Descriptive. The blast furnace should be at least 100 ft. in height, and the hearth should have at least 13 ft. of refractory bottom bonded from top to bottom, instead of layers, to prevent erosion from lifting single layers in the form of large salamanders. The tuyere section must be so constructed that no cracks or lines are available for egress of cinder. The bosh should be strong and properly cooled. The diameter of the bosh is definitely related to hearth diameter, angle or bosh, and batter of inwall. The modern furnace should produce at least 1,000,000-1,500,000 tons of pig iron per lining. The shell of the furnace stack should be very strong—double riveted vertically and horizontally, or welded. Top structure should be so designed that as much equipment and counterweights as possible are placed on the ground or in the skip house. Bell equipment, receiving hopper and McKee revolving hopper are essential. The space between the small bell and big bell for a 21-ft. hearth furnace should be about 1400 cu. ft. The skip and skipbridge should be neither attached to the furnace nor supported by it. Downcomers should be brick-lined, and at points of exceptional wear should be lined with cast iron or steel. The dust catchers should be at least 30 ft. in diameter and so constructed as to assist the settling of the dust. The gas washer should wash the gas to at most 0.15 grains of dust/cu. ft. Further cleaning by electrical precipitators is recommended. Flue dust should be caught in a commodious sump or Dorr thickener. The stoves should be of double riveted or welded construction,

and should have the best burner, regulator and control equipment. Stock bins should have a steep angle at the bottom and no sharp corners. Procedure for putting a furnace into blast is described. Mixed charge filling practice is used: 1 skip of ore, 2 skips of coke, 1 of stone, 1 of ore, and 2 of coke (about 80,000-85,000 lbs.) are put on the big bell. Fifteen ft. from the top of the furnace to the stock, or 5 ft. from the closed bell to the stock, is the mark for a full furnace. Several devices are mentioned that assist in improving the distribution in the blast furnace. The beneficiation and sintering of materials for the furnace are of great importance and results in better efficiency. CBJ (2a)

Modern Electric Smelting (Moderna elektriska hyttor) IVAR HOLE. *Tek. Tid.*, Vol. 69, Feb. 11, 1939 (Section *Bergsvetenskap*) pp. 9-11. Descriptive review. The Tysland-Hole or Spigerverk furnace for production of electric pig Fe has been operated for nearly 10 yrs. Two furnaces, 6,000 and 9,000 kva., are in operation in Norway; 2 in Sweden, 6,500 and 12,000 kva.; I—12,000 kva., in Finland; 6, 7,800 kva., in Italy. Japan is building 2 7,500 kva furnaces, and Italy is planning a number of 12,000 kva. units, 2 of which will be started soon. The furnace is designed for reduction with coke and produces a pig Fe with 0.03% S max. and 0.02% P max., equal in quality to charcoal iron, even with a very high S charge. Soderberg electrodes are used, and the power consumption is 2,400-2,600 kw.-hr./metric ton of pig Fe. For foundry Fe high in Si, the power consumption may be almost 3,000 kw.-hr. Electrode consumption is about 17.5-22 lbs./ton Fe. Coke requirement is 800 lbs./2,000 lbs. Fe. It is roughly estimated that the furnace can compete with ordinary blast furnaces when the price of 1 kw.-hr. of electricity is about equal to the price of 2.2 lbs. of coke. The furnace operates with up to 175 volts. A cheap grade of coke may be used, and as the shafts are very low, it is possible to operate with a high percentage of fines in the charge. The gas does not escape through the shaft but is sucked from the furnace room. Its velocity and pressure under the roof are very small, and there is no danger of explosion. The gas is scrubbed and is then used for heating furnaces. It contains a minimum of 80% CO + H_2 by volume. **The Spigerverk Furnace at the Imatra Plant** (Imatraverkens Spigerverksugn) HARRY WILLNERS. *Ibid.*, pp. 11-14. Describes the operation of a 10,000 kw. Tysland-Hole electric pig Fe furnace at the Imatra plant in Finland. The furnace, capacity 90-100 metric tons pig Fe/24 hrs., has been in successful operation for 1½ yrs. The pig Fe contains 0.02% P max. and 0.01% S max. The furnace treats pyrite cinders high in S. Electrical characteristics of furnace and certain details of construction are described. BHS (2a)

Effect of Distribution of Materials on the Working of a Blast Furnace (Influence de la Répartition des Matières sur l'Allure d'un Haut-Fourneau) H. MAGUIN. *Rev. Mét.*, Vol. 35, Dec. 1938, pp. 531-534. Practical. Gas analyses at various points were used to determine effect of varying charging conditions. In certain cases, the charge distribution (which affects the gas distribution) was a very great influence on the amount of coke used and dust produced. The distribution naturally varies with the profile of the blast furnace, character of hearth, etc. Distribution that gives the most uniform permeability must often be changed slightly to avoid hanging. Application of results obtained reduced coke consumption 200 lbs./ton; dust production from 200 to 120 lbs./ton; and Mn lost in slag from 120 to 80 kg./ton. JZB (2a)

Utilization of Blast Furnace Gas for Burning Limestone for Blast Furnace and Steel Furnace Use (Nutzbarmochung von Gichtgas zum Brennen von Hochofen und Stahlwerkskalk) K. GUTHMANN. *Stahl u. Eisen*, Vol. 58, Nov. 17, 1938, pp. 1305-1317. Practical. Low-grade German Fe ores can be beneficiated by roasting; the excessive burdens required can be lowered by using burned instead of raw limestone. Waste blast furnace gas is used to roast the ore and burn the limestone; the burned limestone is much lower in S than if coke-oven or other high-S gas were used. SE (2a)

2b. Non-Ferrous

Electrolytic Refining of Aluminum. A. I. BELYAEV. *Tsvetnye Metal.*, No. 11, Nov. 1938, pp. 84-93. Research. Fluorides as electrolytes require very high temperatures (1000° C.); chlorides can be electrolyzed at lower temperatures but are not so stable as fluorides. The authors sought an electrolyte composed of fluorides, with a lower melting temperature. Several electrolytes were prepared in which BaF_2 varied from 30 to 40% and NaF + AlF_3 from 60 to 70%, with mol. ratio of NaF:AlF_3 varying from 1.25 to 1.5. Experiments showed that BaF_2 raises the solidification temperature and that the decrease in the ratio NaF:AlF_3 lowers it. An electrolyte containing 40 mol. % BaF_2, 36 mol. % NaF and 24 mol. % AlF_3 was chosen for further experiments. It solidifies at 842° C.; Al_2O_3 dissolves in it to the extent of 1.7% and lowers its solidification temperature to 830° C. Laboratory experiments were made, using graphite containers, to study the effect of variables, such as temperature, current density, time, admixtures, etc., on an anodic melt containing 35.32% Cu, 0.12% Fe, 0.30% Si and 64.24% Al. Tests made at temperatures from 830° to 900° C. showed that the best recovery of Al is obtained at 850° C. The difference in quantity of Al at the anode and that recovered at the cathode is 1.8%, *i.e.*, nearly equal to the value of the solubility of Al in the electrolyte. The temperature of electrolysis does not affect the purity of the Al on the cathode. Tests, using current densities from 0.75 to 6.0 amp./cm.², showed that the recovery increases with current density, and again that current density has no effect on the purity of cathodic Al. To determine the influence of time, tests were made on an anodic sample containing 35.48 Cu, 4.06 Si, 0.64 Fe and 60% Al. With time periods from 90 to 360 min. the cathodic recovery was the same, while dissolution of Al on the cathode decreases with time These tests also showed that increases of Fe to 1.5%, Cu to 65%, and Si to 7% do not result in increase of these elements in the cathodic Al. A series of anodes were made to study the effect of admixtures of various elements on the purity of cathodic Al. These melts were electrolyzed at 850° C. with current density of 5 amps., using the first electrolyte. Metals less noble than Al go into solution but are not deposited on the cathode, except mechanically, and therefore accumulate in the electrolyte. Polarization voltages were found to vary from 836 to 1173 mv. at various conditions (temp., C.D., conc.). They increase with current density and concentration of Cu in the anodic melt, and decrease with increasing temperature. BND (2b)

A Survey of the Patent Literature on Methods of Recovery of Alumina from Clay, Kaolin and other Siliceous Aluminum Minerals by Means of Aluminum Sulfide (Gewinnung von Tonerde aus Ton, Kaolin und anderen Kieselsäurehaltigen Aluminiummineralien über das Aluminiumsulfit in der Patentliteratur) WILLIBALD MACHU. *Metall u. Erz*, Vol. 35, No. 19, 1938, pp. 499-510. Review. Because of the exhaustion of good bauxite deposits, the separation of Al_2O_3 from clays and other Al_2O_3-bearing deposits assumes importance. Alkaline separation processes cannot easily be applied to these materials; the acid and electrothermal reduction methods must be considered. The properties of sulphurous acid and its aqueous solutions and their use in clay treatment are considered, followed by a discussion of Al sulphite and its aqueous solutions, their behavior on heating and the possibility of separation of SiO_2 and Fe from the clay. The processes found in the patent literature are critically examined, and finally a commercial process based on the use of sulphurous acid is described. PCR (2b)

Electrode Polarization During the Cathodic Precipitation of Heavy Metals from Molten Electrolytes. S. KARPACHEV & S. REMPEL. *Zhur. fiz. khim.*, Vol. 11, Jan. 1938, pp. 144-148. In Russian. Original research. The apparatus and procedure used in the determination of the potential of cathodes of liquid Pb, Cd or Tl in their molten chlorides (50° C. above their melting point) and at different current densities, are described briefly. The cathode potential varied 20-30 millivolts when the current density was varied between 0 and 300 amps./dm.² From the concept that in the neutralization of a positive ion an electron is transferred from the electrode to this ion, the authors show that the cathode potential may be expected to be independent of the current density whenever the metal atoms and the molecules of molten electrolyte form complexes similar to solvates, and whenever the energy spectra of the electrons in the electrode and those of the positive ions in the molten electrolyte are related to each other in a definite manner. ORS (2b)

Direct Production of Metallic Zinc by the Electrothermic Process. GEORGE F. WEATON & CARLETON C. LONG (St. Joseph Lead Co.) *Metals Tech.*, Vol. 6, Feb. 1939, T. P. 1040, 9 pp. Descriptive of the electrothermic plant at the Josephtown smelter. Sinter from a Dwight-Lloyd machine — ¾ in. + ¼ in. is mixed with coke of the same size and used as a charge. Over 15 tons/day of Zn have been tapped from a single condenser. The power required amounts to 2564 kw.-hr./ton of Zn. The Josephtown condenser is a unique metallurgical development permitting continuous 1-step condensation to metal of large quantities of metal vapor, irrespective of its dilution by accompanying gases. The metal produced is of controlled quality; ordinarily the product falls within the "high grade" specification, containing not over 0.007% Fe or 0.025% Pb, but lower grades with more Pb can be made by increasing the Pb content of the furnace feed. JLG (2b)

Lead Anodes in the Electrolysis of Zinc (Gli anodi di piombo nell' elettrolisi per zinco) LIVIO CAMBI & ROBERTO PIONTELLI. *Chimica e industria (Italy)* Vol. 20, Oct. 1938, pp. 649-657. Original research and an extensive summary of previous work. The results of Rey, Coheur and Herbiet (see *Metals and Alloys*, Vol. 9, Oct. 1938, p. MA 610 L/4) showing that at current densities less than 300 amps./m. cathodic contamination is due mainly to $PbSO_4$ passing into solution are critically examined. This view is confirmed, but with the qualification that at higher current densities the dispersion of PbO_2 is the predominating factor. An electrode of Pb-Ag (containing 0.96% Ag) gives Zn of higher purity than either a Pb or PbO_2 electrode. AWC (2b)

3 Melting, Refining and Casting

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

Effect of Moisture on the Principal Properties of Moulding Sands. J. DEARDEN. *Foundry Trade J.*, Vol. 60, Feb. 9, 1939, pp. 141-143. Original research. The paper is confined to the effect of moisture on sand, especially from a molding point of view. Determinations of moisture content were made with the "Speedy" moisture tester, the readings of which were occasionally checked by weighing samples of sand before and after drying. Before it is possible to evaluate any sand, its characteristics should be tested over a range of moisture contents. From the molding point of view, within the usual range of moisture, increasing moisture gives reduced permeability and green strength, but a much higher dry strength; it also makes the sand easier to ram, in which case there is a danger of the permeability being reduced even lower. The maximum green strength of raw molding sand is developed at a lower moisture content than is required for facing sand, which contains both used and unused coal-dust. This is probably because a portion of the moisture is absorbed by the pores of the coke and the surface of the fine coal-dust, so that more is required to develop the maximum strength of the sand. This may provide an explanation for the statement that the use of coal-dust with a molding sand raises the green strength. The working range of moisture is above that needed for maximum green strength, so that if coal-dust is used and the percentage of moisture kept constant, some of the moisture will be transferred from the clay to the coal-dust, and the green strength will rise. AIK (3)

Regulating Possibilities of the Inverter for Induction Furnace Equipment (Regelmöglichkeiten des Umrichters für Induktionsofenbetrieb) H. O. SCHMIDT. *A E G Mitt.*, Feb. 1939, pp. 107-108. Descriptive. In using the induction furnace, there is a frequency best suited for every material; thus it should be around 1000 cycles with small units and around 100 cycles with large. The power factor decreases during operation and has to be brought to 1.0 again. This is done with capacitors. Instead of steadily increasing the capacity by adding new capacitors, the power factor can be balanced by changing the frequency by means of an inverter. (The inverter is an apparatus built like a rectifier with grid-regulator.) Constant current and constant power factor can be obtained easily—constant power by addition of a small inverter or thyratron. In a given example, the original frequency of 900 cycles was changed during operation slowly to 1200 cycles. JMN (3)

The Present Status of the High-frequency Furnace in Industry (L'État Actuel du Four á Haute Fréquence dans l'Industrie) J. MINSSIEUX. *Rev. Gén. Élec.*, Vol. 45, Jan. 21, 1939, pp. 67-82. Review. Theory, historical development, operating methods and fields of application are discussed at length. The theory shows that for each material a certain minimum frequency, according to its arrangement as secondary circuit, is necessary. For molten Cu, it is 160 cycles per sec., for molten steel 1100, for graphite 6500; but if the secondary is formed of smaller pieces instead of one solid one, the minimum frequency for Cu at 1000° C. is 3500, for steel at 1000° C. it is 25,000, and for graphite at 1000° C., 3,000,000 cycles. Practical arrangements for the circuits and auxiliary apparatus for control are described. Ha (3)

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

Cast Iron in Engineering Construction. J. L. FRANCIS. *Iron & Steel*, Vol. 12, Jan. 1939, pp. 255-260; Mar. 1939, pp. 337-340. Review. Machinability is a function of combined C, and best amount for both machinability and wear lies between 0.6-0.85%. Above 0.85% combined C, free cementite appears and reduces ease of machining. Mn and S tend to stabilize the carbides and reduce graphite in favor of pearlite, or cementite when conditions for pearlite formation are satisfied. When present in proper proportions to form MnS, machinability may be aided. P increases resistance to wear but its effect on machinability is somewhat doubtful, increasing it at times and at others reducing it. Other conditions are more influential and, in general, it is held best to keep P low wherever possible. Melting and molding practice can influence uniformity and quality of castings and markedly influence cutting. Excess moisture, variations in pouring temperature and technique, unequal chilling or knocking out too soon may all lead to the appearance of hard spots. Where chilled cast irons are needed, Mn and S are an aid, while Cr has the most influence of all agents by formation of the double carbide. Further discussion of chilling techniques, types of chill structure, efficient control, chemical analysis and hardness determinations on chilled castings is included. The pearlitic matrix has a potential strength up to 160,000 lbs./in.^{2}, and reduction of this tensile strength depends upon quantity, dispersion, size and shape of graphite flakes. Thus, the chief aim so far is toward accurate control of graphite. The Schuz, Emmel and Lanz processes for making iron are discussed. The Schuz Fe is high in Si and total C, about 3.5% each; the process involves the use of chills and subsequent annealing. The Emmel Fe is low in total C and medium in Si, is cast into cold molds and no heat treatment is needed. P is low and Mn high, and there is a uniform pearlitic structure in both light and heavy sections. The Lanz Fe is made by hot mold process, the molds being kept at a selected value, usually between 100°-400° C., and maximum pearlite is broken up by a minimum of graphite, Si and P. Proper chill action is governed by close attention to C plus Si ratios. Close metallurgical control is necessary; the product is low in tensile strength but exhibits good shock resistance. In a new Corsalli patent, the Fe is made with low total C from an all-steel charge, and the coke is sprayed with lime to lessen C pick-up. Discussion of Meehanite process is included, and comparison tables are given for it and gray Fe. Ni-Tensyl is made by inoculating the melt with a mixture of Ni and FeSi. The final product is very fine and dense, giving tensile strengths up to 60,000 lbs./in.^{2}. No special furnace is needed beyond a cupola capable of handling heavy steel ratios. See also *Metals and Alloys*, Vol. 10, June 1939, p. MA 369 R 2. HFT (3a)

Casts Diesel Engines For Trucks. *Foundry*, Vol. 67, Mar. 1939, pp. 22-25, 72, 75. Practical description of the founding practice at plant of Mack Trucks, Inc. Both ferrous and nonferrous parts are cast for the Diesel engines. A special alloy for valve insert rings is melted at a temperature of over 3000° F.; it is resistant to corrosion, wear, creep and high temperature, and is made from a charge containing about 60% steel, 40% Ni, with a C content of 1.40%. Crankcase and other castings are made of an alloy containing 91% Al, 2% Cu and 7% Si, melted in drum type revolving open flame furnaces. Composition of alloy iron for cylinder blocks is: Total C, 2.80-3.30%; combined C, 0.55-0.80%; Mn, 0.50-0.75%. Tensile strength is between 38,000 and 40,000 lbs./in.^{2} Alloy iron in cylinder heads differ from the iron in blocks. Heads require dimensional stability, owing to their being subjected to higher temperatures. Composition of the heads is: Total C, 2.90-3.30%; combined C, 0.65-0.80%; Mn, 0.50-0.80%; Si, 1.50-1.60%; Ni, 2.00-2.50%; Cr, 0.30% max. For brake drums, a Ni-Cr cast iron has been developed. Includes discussion of various stages in production of mold for cylinder blocks. VSP (3a)

Oxides of Vanadium in Iron-refining Slags. A. N. MOROZOV. *Metallurg*, Vol. 14, Jan. 1939, pp. 15-27. In Russian. Research. Synthetic slags of various V oxides and CaO or SiO_2 were melted in N_2 in contact with metallic Fe. Chemical mineralogical analyses of the oxides and the slags showed that in basic slags the V is present in the form of highly dissociated compounds of V_2O_3 with FeO and CaO, and possibly with MgO and MnO. In acid slags the V_2O_3 is chiefly free. In both types of slags higher oxides of V are formed by oxidation of the upper slag layers. The formation of stable compounds of V_2O_5 with CaO in the liquid slags is impossible because the Ca vanadates decompose below refining temperatures. BZK (3a)

Manganese in Steel Production (Das Mangan in der Stahlherstellung) E. DIEPSCHLAG. *Metallwirtschaft,* Vol. 17, Dec. 9, 1938, pp. 1299-1302. Discussion. The importance of Mn in steel production is emphasized. Considering the Mn in steel (0.4%), in the slags and that lost in the blast furnace, the author estimates that approximately 8,000-10,000 tons of Mn are used for every million tons of steel produced. German experience during the World War indicated that Mn is indispensable in steel production. Attempts were made to replace the Mn by Al and Ca alloys, silicides and Ti, but the substitutions were not successful. Mn functions not only as an alloy addition in steel but also takes part in metallurgical reactions. The author discusses the minimum amount of Mn necessary to produce good steel by considering the metallurgical reactions in the basic open hearth. Equilibria between FeO in slag and bath and between FeO and Mn as determined by Körber and Olsen are considered. Study is also made of the equilibrium between FeO and C. In the temperature range involved in steel refining, the Mn and C equilibrium curves have no intersection and, therefore, no stable equilibrium is possible at any concentration in the Fe-C-Mn-O_2 system. Concentrations reached during melting are labile states. Because of this, it is not possible to unequivocally determine the least amount of Mn necessary to produce a good steel. GA (3a)

Beneficial Effects of Chromium and Silicon Additions to Cast Iron. *Iron Age,* Vol. 143, Feb. 2, 1939, pp. 42-44. Experimental. Superior physical properties and excellent uniformity in castings of varying sections are obtained in low-Cr cast iron by ladle additions of part of the Si to a base iron. The castings are free from "dendritic" or "eutectic" ferrite-graphite structure. Ferrite of such formations is eliminated by Cr, which also stabilizes cementite, increases oxidation resistance, etc. Cr is added either to the cupola by means of ferrochrome briquets, or to the ladle by means of foundry grade ferrochrome. Analysis of the base iron was: 3.24% C, 2.25% Si, 0.59% Mn, 0.14% P and 0.12% S. Addition of 0.45% Cr eliminates free ferrite and develops a pearlitic structure. Step-bars cast from the base iron showed no chill in the section down to 1/8 in. with 0.45% Cr, and with 0.77% Cr, the iron was gray in 1/4 in. section. The most important effect of Cr is that it improves wear resistance of cast iron. Various effects of alloying elements are influenced by Si and the manner in which it is added. A 0.5% Cr iron with Si added in cupola has a Brinell hardness of 430 in 1/4 in. section. A 1% Cr iron with Si added in the ladle has a hardness of 320 Brinell in 1/4 in. section, while without ladle-added Si, Brinell hardness is 450 in 1/4 in. section. VSP (3a)

Gating Technique in Iron Founding (Einguss- und Anschneidetechnik in der Eisengiesserei) *Giessereipraxis,* Vol. 59, Oct. 9, 1938, pp. 415-418; Nov. 6, 1938, pp. 455-462; Vol. 60, Jan. 1, 1939, pp. 2-7. Practical. The requirements that gates have to fulfill in casting technique are considered; simplicity in gating is stressed. Numerous examples are given of the most common methods of gating with simple and intricate castings to assure sound castings. An attempt is made to standardize and calculate the gate and sprue cross sections. Numerous examples and many practical hints are given. Gate, runner, sprue and casting time should have a definite relation, to attain the most efficient and useful application of gates. The most favorable ratio of gate cross sections, and of other factors is outlined. The ratio of 1/0.9 all sprues of a mold is the following: 1/1.2/0.9. When this ratio is obtained in practice, the liquid Fe enters the parts cast at the same time and at equal amounts per unit time, independent of the location of the sprues with respect to that of the gate. In examples the calculation of the Fe amounts required, of the gating cross sections, and of other factors is outlined. The ratio of 1/0.9 between gate and sprue cross section is given as correct for casting without runners. GN (3a)

Open-hearth Furnaces (Ueber Siemens-Martin-Öfen) J. CARMANN. *Berg-u. Hüttenmänn. Monatshefte,* Vol. 87, Mar. 1939, pp. 49-58. Practical. Based on actual open-hearth operating data, a survey is made of those conditions by which the melting capacity can be increased with incidental shortening of the melting time. Three ways are discussed: Increase of hourly energy supply by using high-grade fuel, increase of hourly energy supply with the same fuel, and increase of the useful heat by larger temperature gradient with higher preheating temperatures and better waste gas utilization. Diagrams of heat content of various combustion gases, hearth capacity as a function of temperature, wear and heat losses in the combustion chamber, and its insulating methods are given. The location and direction of the flame in the furnace is determined solely by the construction of the furnace, not by the buoyancy of the flame, which is only a small fraction of its kinetic energy. Chromite-magnesite bricks have proved far superior to silica refractories as the softening point of the former is not reached even at the highest furnace temperatures, and the heat conductivity is only about half (11,900 cal./m.^{2}/hr. losses for silica against 5,900 for chromite-magnesite). Ha (3a)

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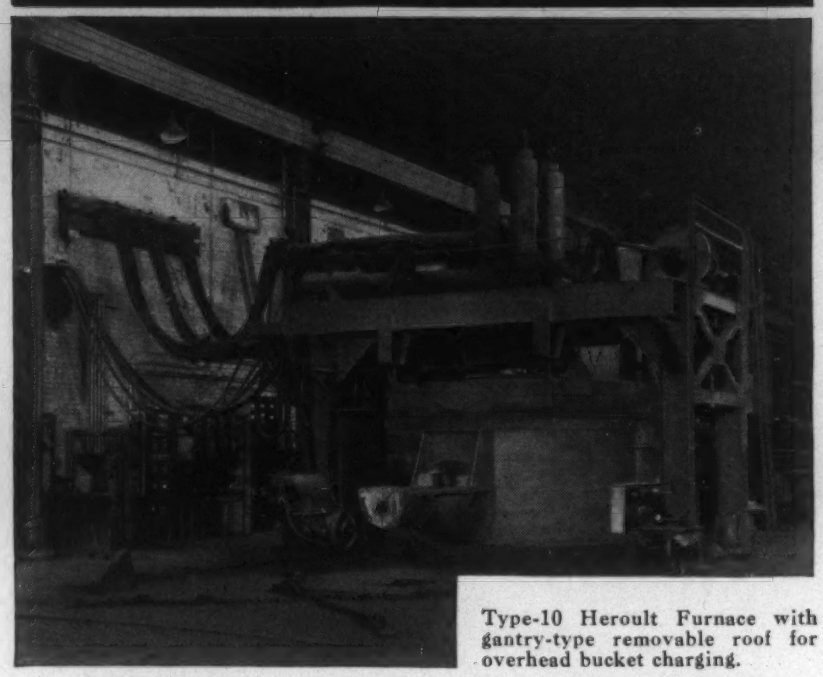

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3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

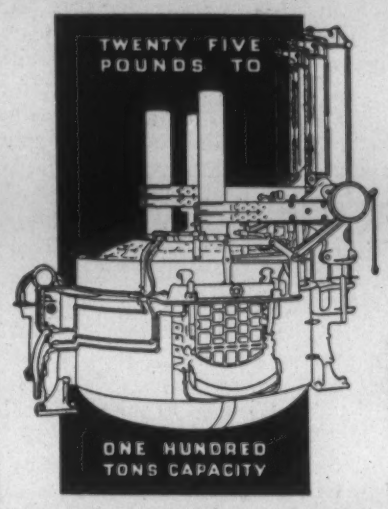
The Formation of Cracks in Aluminum Alloys under the Influence of Solidification and Cooling Stresses. A. A. BOCHVAR & M. K. KHAKIMDZHANOVA. *Metallurg,* Vol. 14, Feb. 1939, pp. 75-80. In Russian. Practical. Al alloys containing 2, 4, 6, 8, 10, 12% Si and 4, 8, 12% Cu were investigated. The tendency of Al-Si alloys to form cracks under the influence of solidification and cooling stresses was sharply reduced by increasing the addition of Si up to eutectic composition. The modification of silumins with ⅔ NaF + ⅓ NaCl had no practical effect upon the tendency to form cracks, whereas 0.15% Na increased the tendency somewhat. Fe greatly increased the tendency to form cracks in low-Si alloys; in alloys with 5-6% Si the effect of Fe was weaker, and in a eutectic alloy the effect was practically absent. The influence of Fe was dependent upon its concentration. Thus, in alloys containing 2% Si, there was a noticeable effect owing to 1% Fe, while in alloys with 5-6% Si, the deleterious effect starts with 1.5% Fe. In regard to the Al-Cu alloys, the addition of Cu reduces the tendency to form cracks. However, even the alloy with 12% Cu showed a greater tendency to form cracks than did the alloys with 6 or 4% Si. BZK (3b)

Measurements on Brass Permanent Mold Castings (Messungen an Messing-Kokillen-Formguss) W. CLAUS. *Metallwirtschaft,* Vol. 18, Feb. 24, 1939, pp. 161-164. Research. The physical properties of 3 brasses: Ms 58 (58.32% Cu, 39.0 Zn, 2.27 Pb), Ms 60 (60.58% Cu, 37.66 Zn, 1.53 Pb) and Ms 00, an unclassified brass (61.12% Cu, 33.2 Zn, 1.89 Pb, 1.52 Sn and other impurities) as cast in permanent molds were determined and compared with those of sand cast brasses. Tensile properties and Brinell hardnesses were determined at temperatures ranging from 18° to 250° C. The tensile specimens were machined from bushings 5½ in. long and 1.2 in. in diameter cast in permanent molds. The metal was poured at 950° C. into molds that had been heated to 450° C. The room temperature properties of the brasses Ms 58 and Ms 60 are respectively: Tensile strength, 48,400 and 47,500 lbs./in.^{2}; yield strength 21,100 and 18,900 lbs./in.^{2}; elongation 13.4% and 22.47%. These properties are superior to those of the same alloys in the sand cast condition. GA (3b)

Non-ferrous Foundry Practice. XIX. Silicon Bronzes and Brasses. J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 54, Mar. 17, 1939, pp. 315-319. Practical. Si-bronzes are Si-Cu alloys, containing some 3-5% Si, with small amounts less than 2%. Si-brasses are true brasses in which the Si is merely an addition agent. These bronzes usually have a greater solidification shrinkage than 88:10:2 and are a little more difficult in the foundry, but have advantages over gunmetal in being readily forgeable and cold workable; the strength and ductility rivals those of low carbon steel, with greater corrosion resistance. Under normal conditions of cooling of the Cu-Si-Mn alloy, the structure may show primary crystals of Cu-rich constituent, gradually changing to a ground mass of Mn-rich constituent, with no definite demarcation between them. Cu alloys containing as high as 20% Mn are usually quite homogeneous. The Mn present in Si bronze is completely dissolved in Cu, adding to the hardening effect of the Si. Alloys of 2.5% Si and 0.2-0.9% Fe possess high strength, low elongation and normal hardness compared with normal Sn bronze. Their fluidity is very high and anti-frictional properties low. For shaped castings, alloys with 3-5 Si, 1-2 Fe, 1 Mn and 1-5% Pb, and for hydraulic castings, 3-5 Si and 1-5% Pb are recommended. Molding practice for Si bronze follows gunmetal practice. The addition of hot metal to the riser boshes after pouring will aid feeding materially. Runner gates or gates should be located near a riser. Runner gates should be made to avoid turbulence and must enter the mold near the bottom. The casting temperature should be high enough to avoid entrapped gas bubbles and cold shuts. A suitable range for normal work is 1080°-1120° C. Melting should be rapid. A graphite stirrer is preferred to Fe. Excessive stirring is inadvisable. A glass cover is used. The Cu-rich Si brasses can be readily rolled or drawn, and are mechanically superior to the usual brasses. Cu-Zn-Si alloys lose ductility and strength with Sn or Ni additions. Cu-Si-Zn-Sn alloys are suitable for bearings. Pb has a bad effect on mechanical properties. Si brasses are very fluid and particularly suitable for chill castings. The best chill cast alloy contains 81-82 Cu, 4-5 Si and 14% Zn. Fe, Zn, Sb, As and P reduce mechanical quality and increase film inclusions, intercrystalline shrinkage and porosity. Al improves mechanical qualities, but increases film formation and is, therefore, regarded as harmful. Although Pb impairs mechanical quality it improves anti-frictional properties. Solidification shrinkage is high and large risers are necessary. A number of small gates, well distributed, give better results than a few large ones. The total gate area should be about 50% greater than for an equivalent brass casting. A glass flux should be used and the scrap charge should not exceed 25%. Melting should be rapid and stewing avoided. The flux should be thickened with sand, and the metal skimmed. Normal casting temperature is 1160° C. 16 references. **XX. Nickel Silver, German Silver, White Brasses, Nickeline, etc.,** *Ibid.,* Mar. 24, 1939, pp. 349-353. Cu-Ni-Zn alloys may be classified as brasses containing Ni or as Cu-Ni alloys containing Zn. Ni brasses are considered to contain a maximum of 10% Ni, and alloys with a minimum of 15% Ni are classified as Ni silver. 18% Ni guarantees color and corrosion resistance. Alloys of 20-22% Ni are commonly used. With high Ni content, the total Ni-Zn should not be less than 30%. With low Ni content, the total Ni-Zn should not be less than 45%. The presence of C, O_2, or S, absorbed during melting, is destructive of quality. With Ni silvers and other non-ferrous alloys containing Ni it is desirable to melt under oxidizing conditions and then deoxidize before pouring. The addition of Sn hinders C absorption. C may embrittle wrought alloys because of the formation of Ni_3C, on annealing, if the temperature exceeds 700° C. The C and O_2 should not exceed 0.04% Si and S should be absent. Although P is used to deoxidize, it must not be added in such quantity as to allow any to remain in the alloy, or embrittlement will result. Al is used as a deoxidizer and may be used up to 2%, above which embrittlement may result. The presence of Al makes the alloy heat treatable. Fe increases hardness, strength and ductility and whitens the alloy. Pb effects Ni silver in about the same manner as in brass. Mg and Mn are both used as deoxidizers and desulphurizers. Excess of Mg renders the metal sluggish and dirty. By reason of its general hardening effect, the presence of Sn in wrought alloys is most undesirable. A molding sand of good permeability is needed. Except for small work, dry sand is used. The most satisfactory methods of gating are similar to those used in steel foundry practice. A desirable range of casting temperature is 1250°-1350° C., varying between these limits according to composition of the alloy and mass of the casting. Pouring temperature should be higher with Ni content and lower with Zn content. **XXI. Copper-nickel Alloys.** *Ibid.,* Apr. 7, 1939, pp. 393-398, The Cu-Ni alloys form a continuous series of solid solutions. The variations of mechanical properties with composition are generally represented by smooth curves. Practically all compositions find commercial application. The alloys are characterized by high strength and ductility with excellent resistance to high temperatures and corrosive agents. These properties improve

with Ni content, and alloys containing as much as 80% Ni are common. The practical difficulties in melting Cu-Ni alloys resemble those with Ni silvers. With high Ni, they are aggravated by reason of high melting and pouring temperatures, the fairly high solidification shrinkage and increasing tendency with rise in Ni toward the absorption of gases; the release of these on solidification gives rise to unsound castings. For melting large quantities of metal, an electric furnace possesses decided advantages. For the low-Ni range, even the natural draft pit furnace can be used. In melting, MnO_2 and a flux are added to the charge. Deoxidation may be accomplished with Mn or Si. Mn improves fluidity and slightly increases strength and ductility. For soundness alone, 0.02-0.03% Si is sufficient. Additions of 0.025% Mg are used to care for S. Fe is unnecessary but hard to keep out. Pb is dangerous as it causes porosity, hot shortness and brittleness. Zn is without advantage and increases corrosion by salt water. Melting and pouring temperatures range from 1180° C. for 80 Cu-20 Ni to 1570° C. for 20 Cu-80 Ni. A very refractory and permeable molding sand is essential. Green sand may be used for very small castings and even larger ones where soundness is not essential. For larger, more important work, the mold should be dried. Solid shrinkage or contraction is high in these alloys and, therefore, adequate feeding must be provided. Large downgates are not recommended, while a choke feed will assist in eliminating dirt and oxides. A vertical casting gives better feeding. It is advantageous to gate through the feeding risers in much the same manner as in Mn-bronze. 11 references. **XXII. Aluminum Alloys.** *Ibid.*, Apr. 28, 1939, pp. 463-467. The development in founding of light alloys has made rapid progress in the last 15 yrs. There is much overlapping in the various alloys, and some of them have little justification for existence. In their early development the Al-Zn alloys were attractive to the foundryman. The addition of Cu to these alloys improves their hot shortness and strength. The chief industrial Al-Cu alloys contain 4, 7 and 12% Cu. The 7% Cu alloy finds chief application in die castings; the 12% Cu alloy has greater strength and hardness at elevated temperatures than 7 Cu. The 7-12% Cu alloys are not specifically heat-treatable, except for stress relieving treatments. The 4% Cu alloy is susceptible to heat treatment and is the basis for the important series of heat treatable wrought alloys containing such elements as Mg and Si besides the Cu. The general treatments consist of a high temperature solution treatment, followed by aging at room temperature. An alloy of 4/2/1.5 Cu/Ni/Mg (Y-alloy) is hard and strong at 250°-300° C., and has excellent thermal conductivity. It is difficult to cast and somewhat inferior to the Si-Al alloys in corrosion resistance, but superior to many other Al alloys in this respect. Additions of 2-3% Si to 6-8% Cu alloys improves the casting qualities. The Si alloys, important because of their low densities and excellent corrosion resistance, are divided into 2 classes: Those of low Si (5%), which are handled in the foundry in the usual manner, and those of high Si (10-14%), which have to be modified for good castings. With either the modified or unmodified alloys, no practical improvement is obtained, either by aging or heat-treatment. Small additions of Cu or Mg render low-Si alloys responsive to heat treatment. The suitability of high-Si alloys for pistons is greatly reduced by their softness and weakness at the required working temperatures, but, by suitable additions, the low thermal expansion can be maintained and these weaknesses remedied. An alloy of 11.5-14.5% Si, 1% Mg, 2.5% Ni and 0.8% Cu is finding considerable use for pistons. The use of 0.6% Mn, 0.6% Mg in high Si alloys is becoming wide. 3% Ni increases the strength, and maintains the good castability and the same low expansion as the straight alloys. Al alloys of 3-10% Mg show good strength and shock resistance. For Part XVIII, see *Metals and Alloys*, Vol. 10, June 1939, p. MA 337 L/1. RWB (3b)

Defects in Non-ferrous Ingots. G. L. BAILEY. *Metal Ind., London*, Vol. 54, Feb. 24, 1939, pp. 239-242; Mar. 3, 1939, pp. 269-271. Practical discussion. The subject is divided into "surface" and "internal" defects. Surface defects dealt with include oxide patches, laps and splashes, blowing and mold defects, and inverse segregation. Oxide formation during pouring can be avoided in alloys composed of metals with readily reducible oxides by pouring in a reducing atmosphere produced by coating the inner face of the mold with a suitable volatile material. Highly oxidizable metals, however, must be poured under non-turbulent conditions. Where strong oxide skins are formed the Durville process may be used. In Al-free brasses this can be overcome by additions of P provided the change in properties caused by this addition is not prohibitive. Both blowing and surface cracking of the mold are avoided by using copper-faced molds. Inverse segregation is particularly serious in Al-alloys; it is caused by the formation of a surface shell, which in shrinking from the mold wall leaves a space into which the brittle eutectic runs. No remedy for this is suggested. Internal defects are considered in four phases: Evolved gases, entrapped gases, shrinkage defects and non-metallic inclusion. The use of inclined molds tends to increase the tendency to trap



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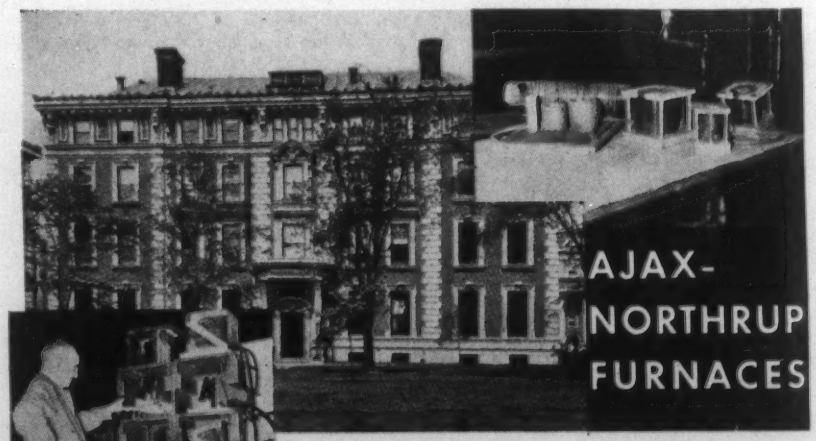

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gases under the upper surface of the ingot. For the complete avoidance of injected gases, some method of non-turbulent pouring that avoids the carrying of the gases into the mold is desirable. It is almost impossible to avoid central shrinkage unsoundness in long thin slabs, such as are widely used for casting copper alloys for strip rolling. From the practical view the best way of reducing internal shrinkage cavities is to cast thicker sections of shorter length. Contraction after solidification, causing "hanging" in the mold, can cause cracking, particularly if the alloy is hot short; this may limit the dimensions of ingots that can be cast. Recommendations for the production of high quality shapes are given. Of the unconventional pouring methods the Durville process is one of the earliest and most widely used. There are obviously some undesirable features in this process but by it rolling slabs of the highest quality can be made. Another method recently advocated for pouring rolling slabs is the use of the "Erical" vertical water-cooled mold in which the plates forming the mold faces are of high Ni-alloy designed to expand inward after pouring, thus compressing the ingot during solidification. The thickness of slab recommended is 3 to 4 in. and a considerable amount of machining is necessary on the under and upper surfaces prior to rolling, but a shape of very high quality is obtained. Many methods of pouring Al with a minimum of turbulence have been advanced. The main feature of these is that the mold has a slit down one side through which the metal is introduced, and during pouring the mold is lowered and the slit closed RWB (3b)

Nickel in the Non-ferrous Foundry. F. HUDSON. *Foundry Trade J.*, Vol. 60, Mar. 30, 1939, pp. 265-266; Apr. 6, 1939, pp. 287-289. Up-to-date review. The alloy selected for this discussion is a heavy duty bronze containing 5 Ni, 5 Sn, 2% Zn, remainder Cu; an Admiralty gunmetal, in which the composition has been modified by replacing 5% Sn with Ni. The alloy is susceptible to heat-treatment, so that castings can be readily produced having mechanical properties similar to those of high-tensile brass. For simple castings, this material presents no serious difficulties, and the practice common to the ordinary bronze alloys can be employed quite satisfactorily. For the very best results, however, particularly after heat-treatment, certain modifications in foundry technique are desirable. In order to develop maximum quality in castings, it is essential, in the first place, that they be free from porosity and interdendritic shrinkage. Interdendritic shrinkage in non-ferrous castings can usually be ascribed to unsuitable placing of gates and risers, incorrect pouring temperature, or gas absorption because of improper melting or deoxidation methods. Suggested correctives are: (1) Pour at a suitable temperature and in such a manner as to obtain proper heat and metal distribution in that part of the mold forming the casting. Heavier sections should be the last to solidify, and suitable steps taken to supply hot metal at these parts for feeding purposes. (2) Employ well-proportioned risers on sections requiring feeding, and be sure that the metal in the risers is hotter than that in the casting (3) Adopt choke gates for cleanliness and pouring control. A range of pouring temperatures between 1200° and 1290° C. has given satisfactory mechanical properties so far as test-bars are concerned, and this may be modified for casting requirements to, say, 1180° C. for heavy work, 1200°-1220° C. for medium, and 1220° to 1290° C. for light castings. The following procedure has been found to work well in oil-fired crucible furnace heats using virgin metal: (1) Melt down the Cu and Ni, using a moderately oxidizing flame. (2) When thoroughly melted, oxidize the heat with 3 oz. of cuprous oxide to 100 lbs. of metal, stirring in the oxide with an Fe rod. Hold the heat 3-5 minutes. (3) Deoxidize the melt with 3 oz. of 15% phosphor copper per 100 lbs. of metal. (4) Add the Zn, followed by Sn. (5) Finally, complete the deoxidation by a further addition of 4 oz. of phosphor copper per 100 lbs. of metal. Melts treated with copper oxide respond more vigorously to age hardening. Do not use charcoal as a cover, and do not use wet coke. The latest work by Kihlgren (see *Metals and Alloys*, Vol. 10, Feb. 1939, p. MA 87 L/4) indicates that the presence of as little as 0.05-0.10% Pb retards or completely inhibits response to heat-treatment. Small amounts of Si also tend to prevent the occurrence of age-hardening constituents. AIK (3b)

The Use of Nickel Scrap and Waste in the Foundry (Zur Verarbeitung von Nickelschrott und -abfällen in der Giesserei) E. R. THEWS. *Giesserei*, Vol. 26, Mar. 10, 1939, pp. 121-123. Practical. The methods to regain pure Ni by melting Ni scrap is discussed from the practical founders' standpoint. The best melting furnaces for this purpose are the induction, either high or low frequency, because of the absence of harmful gases or other contamination. A slag should be produced that not only protects the melt against air but also refines; sodium or potassium carbonate is recommended as an addition, as either of these reduces the S and As content. The best purifying agent was found to be a 50-50 Mg-Al alloy that simultaneously deoxidizes and desulphurizes; only 0.125% of the Ni present need be added to this alloy to obtain complete deoxidation and desulphurization. Means have to be provided to prevent reoxidation. The various steps in purifying the Ni scrap are treated fully. Ha (3b)

4 Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER

AND H. W. GRAHAM,

SECTION EDITORS

The Rational Cutting of Metals (La Coupe Rationnelle des Metaux) H. FREUND. *Tech. Moderne*, Vol. 30, Dec. 15, 1938, pp. 867-869. Mathematical treatment. $V = C/\sqrt[k]{S}$, where v = cutting speed in m./min.; s = chip section in mm.^{2}; and c and k are constants depending on the metal being cut, as given below. Results are based on 1 hr. tool life with high speed steel containing 16-18% W.

Metal being cut	c	k
Electron metal	400	1.31
Brass (Brinell 80-120)	112	1.62
Bronze (85% Cu, 5% Sn, 10% Zn + Pb)	77	2.28
(85% Cu, 9% Sn, 6% Zn)	77	2.28
Cast steel (Brinell 135-150)	28.7	2.75
O. H. Steel (T. S. 47— 64,000 lb./in.^{2})	55	2.44
(T. S. 57— 71,000 lb./in.^{2})	44	2.44
(T. S. 72— 85,000 lb./in.^{2})	35	2.44
(T. S. 87—100,000 lb./in.^{2})	27.7	2.44
(T. S. 101—114,000 lb./in.^{2})	17.8	2.44
Ni-Cr alloy steel (Brinell 210-220)	28	1.77

It will be noted that a slight reduction in speed makes possible a sensible increase in chip section. JZB (G-4)

Observing Plastic Deformation with the Microgrid. F. N. RHINES & R. WARD. *Metals and Alloys*, Vol. 10, Apr. 1939, pp. 129-132. Descriptive. The "microgrid" method for observing plastic deformation, and, particularly, for revealing the microscale details of inter- and intra-crystalline movements, is described. The microgrid is simply a very fine grating ruled with a sharp pointed stylus on the polished and etched surface of a sample to be deformed. The grid is photographed before and after deformation, thus permitting the displacement of any point to be measured by comparing the photographs. In practice it is essential that the surface have a perfect metallographic polish and that the etch be of the staining and contrast (etch pit) type rather than the simple grain boundary type. The application of the microgrid method to the deformation of pure cast Zn is described. Microgrid studies must be limited to relatively small reductions made under conditions such that the grid will not be obliterated. Also, the plastic behavior may be studied in a two-dimensional external surface only. FPP (D-4)

A Discussion on Plastic Flow in Metals. *Proc. Royal Soc., London*, (A) Vol. 168, Nov. 1938, pp. 302-317. W. L. BRAGG emphasized the desire for more precise knowledge of the mechanism by which slip occurs in crystals and of the means by which the crystallites formed during slip confer hardness. C. H. DESCH discussed the frequently observed strain markings that, unlike true slip bands, remain after re-polishing and eching. N. F. MOTT suggested an extension of Taylor's theory of strain hardening to age-hardened materials and alloys in general. E. OROWAN described a method of studying the mechanism of plastic flow by observing its dependence on temperature. E. N. DA C. ANDRADE pointed out that there are often several glide planes along which

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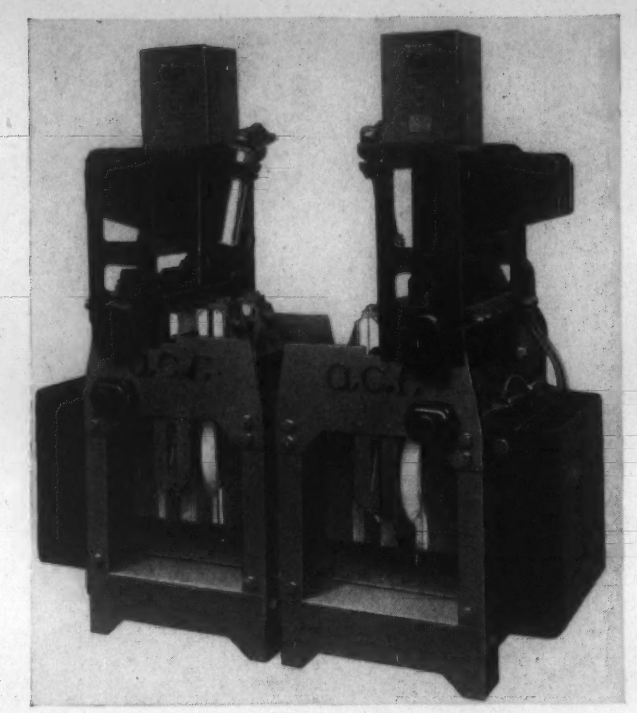

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slip can occur, all nearly equally adapted. Impurities and strain may thus give rise to irregular glide surfaces. With single crystals, it must be remembered that on straining break-up occurs, and they can then no longer be treated as single. G. D. PRESTON described similarities between the structure of work hardened and age hardened samples of 4% Cu-Al alloy. W. H. HATFIELD discussed the difference between brittle and plastic material, and mentioned the effect of cold work in changing face-centered austenite to body-centered ferrite. JCC (D-4)

A New Smoothness Tester. YAEKICHI SEGIGUCHI & ICHIRO HASEGAWA. *Trans. Soc. Mech. Engrs., Japan*, Vol. 4, Nov. 1938, Summary Section p. S-51. In English. Original research. A needle is set at an angle of 10 degrees to the surface to be tested so that only a small portion of the rounded side near the point of the needle touches the surface. The needle is made to move sideways backward and forward and the vibration caused by the roughness of the surface are transmitted to a Rochelle salt pickup. The piezo-electric current is then amplified and recorded by means of an ammeter or an oscillograph whereby the smoothness of the surface is rendered measurable. With this smoothness tester, the following relations were studied: (1) duration of grinding and smoothness, (2) number of revolutions of a cylinder ground and its smoothness, (3) depth of grinding and the smoothness, (4) diameter of a cylinder and its smoothness. Smoothness of finish by turning was also studied. **On the Smoothness of Surface Finished by Various Kinds of Cutting Oils.** *Ibid.*, p. S-63. In English. Original research. Using the author's new smoothness tester (see preceding abstract) the quality of surfaces finished with various kinds of cutting oils was investigated. Mild steel pieces were finished in a lathe and by grinding, and Al pieces were finished in a lathe applying the oils to be tested. Less viscous oils were found to be best suited for mild steel to obtain a smoother finish, but viscous oils are preferable for Al. EF (G-4)

Influence of Shaping Method on the Texture and Structure (Einfluss des Formgebungsverfahrens auf Textur und Gefüge) G. WASSERMANN. *Vorträge Hauptversammlung deut. Gesellschaft Metallkunde*, 1938, pp. 53-56. Research. Earlier investigations have shown that uniform crystal orientation due to cold work depends less on the type of deformation process than on the direction of material flow. The author's experiments substantiated this fact. The origin of fibrous structure and the conditions to avoid it were discussed. The original grain size is of importance. Fibrous structures can be removed only with the greatest difficulty, even by recrystallization. Coarse grain in the as-delivered state favors fibrous structure upon rolling. Therefore, it is advisable to start with a fine grain or to apply light reductions in the first pass and several intermediate annealings at moderate temperatures. The results of cross-rolling experiments to attain distinct properties, particularly with metals of cubic-space centered lattice, were presented. GN (D-4)

4a. Ferrous

Developments in Rolling Flat Steel Products in 1937-1938. STEPHEN BADLAM. *Iron Steel Engr.*, Vol. 16, Jan. 1939, pp. 28-51. Remarkably comprehensive review is given of new continuous sheet and hot broad strip mills placed in operation during 1937 and 1938. Engineering features and design, equipment used, power requirements, bearing installations, auxiliary equipment and operation, and production are considered. Changes in, and additions to existing equipment are discussed as completely as new installations. Skin rolling of strip has been revolutionized in recent years. The 3-high roughing water mill has come into greatly extended use, with 20 such mills sold for use in America and abroad in the last 2 years. The conventional hot sheet mill, whose death knell was sounded 12 years ago, is still in considerable use, and, in fact, some of them have recently been reconditioned rather than replaced, even by companies operating new hot broad strip mills. The most conspicuous feature in the design of more recent broad strip mills, hot or cold, has been the almost exclusive use of bearings of the oil sleeve type, instead of roller bearings, on the necks of back-up rolls. The use of roller bearings on work rolls, however, is still universal. Non-metallic bearings of the phenolic resin type have been greatly extended in use during the past 2 years. In 1937, the continuous sheet and hot broad strip mills produced more than 25% of all the finished rolled steel made in America. CBJ + FPP (E-4a)

The Deformation Process on Cold Rolling Seamless Tubing in a Pilger Mill and on Drawing over a Mandrel (Der Formänderungsverlauf beim Pilgerschritt-Kaltwalzverfahren und Stopfen-Ziehverfahren) H. UNCKEL. *Arch. Eisenhüttenw.*, Vol. 12, Mar. 1939, pp. 423-428. Original research. Seamless tubes of condenser brass and of pure Al were cold rolled in a Pilger mill and cold drawn over a mandrel. To indicate the mode of deformation, the surface was marked with a series of squares. The cut surfaces of the walls of longitudinally sectioned tubes were similarly marked. In cold rolling, these longitudinal sections indicated that the inner surfaces are elongated more than the outer. Evidences of preferred orientation not entirely eliminated by annealing were more noticeable after cold rolling than after cold drawing. The [111] direction along the tube axis was more prominent after cold rolling than after cold drawing. Preferred orientation in tube rolling (biaxial rolling) is, therefore, different from ordinary sheet rolling (uniaxial) in which the [112] direction forms along the direction of rolling. The tensile properties of the rolled and drawn tubes showed no noticeable differences after annealing and subsequent deformation. SE (E-4a)

Relative Machinability of Steels. ALFRED KULLMAN (Am. Tool Works Co.) *Iron Age*, Vol. 143, Feb. 9, 1939, pp. 29-32. Practical demonstration of the effect of alloys, grain size and heat treatment of steels on their machinability. Various steels tested are tabulated. Ordinary "cold-rolled" screw machine steel, S.A.E. No. 1112, was taken as standard. In the case of each test, the character of chips coming from the tool was observed and the effect of materials on cutting tools described in detail. Results show that relative machinability of these materials remains constant for higher speeds, such as when using such tool materials as cemented carbides. Although tests were conducted at 50 and 100 ft./min. with high-speed steel tools, same material might be cut successfully at 300 ft./min. or even 400 ft./min. Demonstration was based on a common method of cutting steel, that is, using 18-4-1 high speed tools. Different types of cutting tools can perform in a different manner than that shown here. Includes a number of photomicrographs. VSP (G-4a)

Design of Modern Slabbing-blooming Mills. LORENZ IVERSEN (Mesta Machine Co.) *Iron Steel Engr.*, Vol. 16, Jan. 1939, pp. 20-27. Design features of numerous modern installations of roughing or slabbing-blooming mills are discussed, as well as electrical equipment, manipulators, slab shear and slab handling equipment. Most slabbing-blooming mills installed recently have been of the 2-high reversing type without vertical edging rolls. With such a mill, the ingot is turned for edging on the horizontal rolls, and as much edging work as desired can be done; a slab ingot can be reduced to any slab width desired, thus eliminating the need for a large number of ingot widths. One new mill can handle 25 in. x 66 in. ingots and can roll slabs 62 or even 64 in. wide. CBJ (E-4a)

4b. Non-Ferrous

The Machinability of Some Substitute Alloys Used in lieu of Free-machining Brass. Zinc-base and Aluminum-base Alloys (Die Zerspanbarkeit einiger Austauschlegierungen für Automatenmessing-Automatenlegierungen auf der Zink—und Aluminiumgrundlage) H. OPITZ & W. ZIMMERMANN. *Maschinenbau Betrieb.*, Vol. 18, Feb. 1939, pp. 59-63. Original research plus review. For free-cutting materials, to be used on automatic lathes, it is important that the chips fall off in short pieces, which can be removed easily by the cooling agent. This can be achieved by careful maintenance of certain cutting conditions, but a better way is to select proper materials. Additions of Mn, Fe, Ti, V and Mo contribute to the free-machining properties of Al-base alloys by forming hard intermetallic compounds with the matrix. The effect of Pb, Cd and Bi is based on their limited solubility, both in the liquid and solid states. The latter additions tend to segregate and weaken the material. Hard intermetallic compounds cause wear on the tools. In practice, both methods combined are used in proportions adapted to the particular type of alloy used. Free machinability of Zn alloys is achieved by Bi addition. The basic alloy must be free from Al or else intercrystalline corrosion occurs. The mechanical properties of either type of alloy are not impaired by proper additions. Various alloys were investigated as to wear on tools under several cutting conditions. The alloy composition is rather critical. It is not necessary to use specially designed tools. The surface quality of substitute alloys is satisfactory.
RPS (G-4b)

Production and Application of Aluminum Alloy Sheet and Strip. *Light Metals*, Vol. 2, Mar. 1939, pp. 98-101. Review. Al alloys for use in sheet and strip form may be of the strain-hardened type or of the age-hardened type. While the strength of the heat-treatable alloys exceeds that obtainable in the strain-hardened alloys, some of the Al-Mg alloys do not fall very short of the maximum strength of the heat-treated alloys. Production of perfect castings is essential for the production of good sheet. Casting practice varies considerably, but the tilting water-cooled mold is probably most used in ingoting. The rolling temperature of most Al alloys is not critical, but some alloys, such as duralumin, have a low melting constituent that must be diffused into the matrix of the alloy before rolling. Some manufacturers prefer to extrude ingots before rolling to aid in breaking up the cast structure. Scrap may be reduced by rounding or beveling the edges of the slab before rolling. Sheet is rarely finished below 1/8 in. thick because of danger of buckling. While coiled strip does not in general exceed 30 in. in width, sheet may be made as wide as 7 feet, and 16 feet long. The strain between anneals in cold rolling varies from about 15% reduction in thickness to 40% reduction. Pack rolling may be resorted to for thinner gauges in finishing sheet. After cold rolling, the strain-hardened alloys are flattened and slit, while the age-hardened alloys are solution treated, usually in a salt bath, and aged in an air furnace. AUS (E-4b)

Some Observations on the Forging of Strong Aluminum Alloys. GEORGE SACHS (Case School of Applied Science) *J. Inst. Metals*, Vol. 64, 1939, Advance Copy No. 824, 23 pp. Practical application of theory. The mechanical properties of forgings, which are generally different in the 3 directions, are discussed in detail. They depend on many factors, the most important of which are: The shape of the forged part, the properties of the alloy and the stock, and the design of the dies. The properties of shaped forgings are determined mainly by the properties of the stock and local reductions. The most serious defects in forgings are cracks in the flash, at the base of ribs, and on the surface of expanded parts. They can be avoided by more or less radical changes in forging practice. Some other sources of manufacturing troubles can be avoided by proper heat treatment.
JLG (D-4b)

The Effect of Aluminum Alloys on the Stability of Drilling Oil Emulsions (Der Einfluss von Aluminium-Legierungen auf die Beständigkeit von Bohrölemulsionen) P. BEUERLEIN. *Aluminium*, Vol. 21, Mar. 1939, pp. 213-214. Research. Several oil emulsions used for lubrication and cooling in machining Al alloys were investigated as to their resistance to disintegration, which had been observed to take place in several cases. Considerable differences exist in the stability against the effect of Al and Al alloys on the emulsion; sometimes de-emulsification and separation of the oil and water occur. This should be considered when selecting an emulsion for Al alloys. Ha (G-4b)

Manganese that Can Be Hot Rolled, and Its Deformable Alloys (Das warmwalzbare Mangan und dessen verformbare Legierungen) W. KROLL. *Z. Metallkunde*, Vol. 31, Jan. 1939, pp. 20-23. Experimental. Mn that has been double distilled and melted under A can be worked in the γ and most of the β region. Quenching does not prevent transformation to the brittle α in this pure material. Addition of 15% Cu lowers the plastic range to 500°. An alloy with 5.1% Cu and 8.9% Ni can be kept plastic at room temperature. GD (E-4b)

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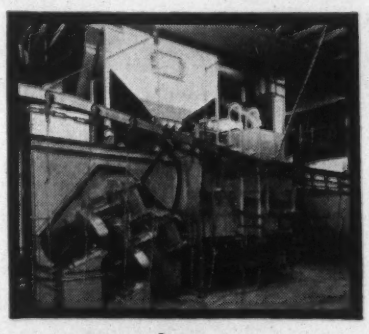
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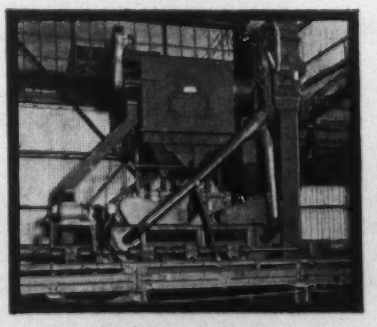
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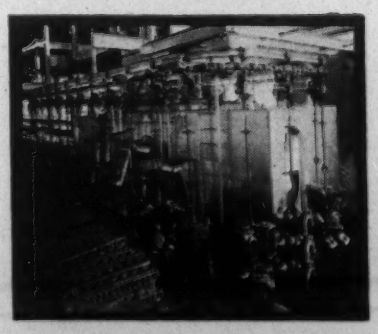
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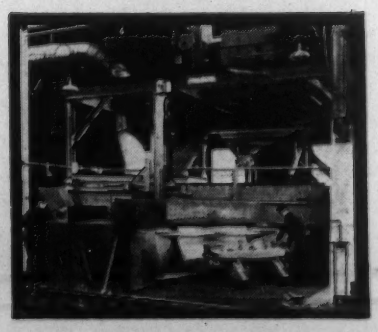
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O. E. HARDER, SECTION EDITOR

Luminous Flame and Its Application. JAMES E. DARE (Public Service Co. of Northern Ill.) *Heat Treating Forging,* Vol. 25, Apr. 1939, pp. 200-203, 207. Review. Luminosity is caused by thermal decomposition of the hydrocarbons into C and H, the C being heated to incandescence. Luminosity is increased by admitting greater amount of secondary air at burner in proportion to primary air; excess fuel, particularly toward end of combustion; lower velocity from burner; increasing preheat temperature of air to about 1700° F., if velocity from burner is low; and increasing thickness of flame. It is reduced by excess air, particularly toward end of combustion; H_2O vapor; better mixing; increasing preheat temperature of air to about 1700° F., if velocity from burner is high; and turbulence. Advantages of luminosity are: Increased rate of heat transfer, more uniform temperature control, less maintenance work on furnace refractories, greater degree of turn down of burners, and formation of scale, which requires much less trouble to remove as well as reduction in amount of scale. Successful applications of luminous flames include heating stock for rolling and forging, soaking-pits, open-hearth furnaces, heat treating of steel, side-fired galvanizing tanks, and large Pb melting-pots. Furnaces should be sufficiently well constructed to minimize air infiltration. Combustion volume should be sufficiently large to minimize turbulence. Luminous combustion should be applied where a short flame cannot distribute heat properly. Standard burners rated at 250 cu. ft./hr. (natural gas 1000 B.t.u./ft.^{3}) to 12,000 cu. ft./hr. are available. Majority have maximum turn down of 20 to 1. Generally, air and gas pressures of 3-14 in. H_2O column are required to maintain normal rating and control and maximum efficiency. Fundamental design involves control of amount of primary and secondary air admitted at burner. Burners available can produce satisfactory luminous combustion when utilizing gases varying from a mixture of coke-oven and blast-furnace gas of 350 B.t.u./ft.^{3} to natural gas of 1500 B.t.u./ft.^{3} Some special burner design applications are also discussed. MS (5)

Recirculating Air Heating for Industrial Furnaces. EDWARD STEPHENSON, JR. (Surface Combustion Corp.) *Amer. Gas Assoc., Industrial Gas Sec., A.G.A. Industrial Gas Sales Conference,* Mar. 1939, 6 pp. Discussion of the fundamentals of application of heated air to convection heating furnaces. Trend in furnace construction is toward steel. Various types of construction may be used. Many types of linings are available, each having its place, dependent upon temperature, expected life and capital investment. Various types of conveying mechanisms used in high-temperature furnaces are all suitable for this type. Fundamental point is that ratio of net weight to be heated plus conveyor to be heated to the net weight only shall be as close to unity as possible. Amount of heat to bring heater to desired temperature should be at a minimum. Heater should also have minimum weight and should be totally enclosed, accessible, compact, efficient from the standpoint of heating medium, and constructed to last at least as long as the furnace shell. Burner equipment should be able to burn completely the type of fuel specified with automatic proportioning between air and fuel, and should meet requirements of the control equipment and temperature ranges specified. Fan should give maximum velocity, consistent with good heat practice and minimum power input, minimum cooling, and long life without maintenance. Radial type is most successful. Temperature control equipment can be of any of the well known available types. Throttling type of temperature control is recommended. Safety control should do everything that a man of more than average intelligence would do. Supplying heated air to top and bottom of heating chamber is advantageous. Return ducts should be from bottom of furnace, and when located at ends, the simplest application to furnace and maximum heat efficiency can be secured. MS (5)

Dolomite Bricks for Metallurgical Purposes. ALFRED B. SEARLES. *Iron Steel Ind.,* Vol. 11, Sept. 1938, pp. 593-596. Practical discussion. Comparison is made between true dolomite and the often misnamed dolomite or magnesian limestone; the former consists of crystals all of one kind and contains the carbonates of Mg and Ca in the form of a compound, while the latter is made up of the mixed crystals. Presence of silica and alumina greatly lowers the melting point of both. Magnesite (MgO) has a higher melting point than either of the calcined carbonates, being 2700° C. as compared to 2300° C. for true dolomite when neither contains more than 5% impurities as other oxides. The relative inertness of dolomite bricks make them especially useful for furnaces where basic slags are used. Chief disadvantage is the tendency of the lime present to cause disintegration in the presence of moisture, but in a well prepared chrome-dolomite brick this difficulty is obviated and a melting point of 2300-2800° C. can be obtained. Dolomite bricks should be laid in a mixture of light magnesia with water to form paste. Separate attention is given the melting point, separation of lime, use of retarders and neutralizers to prevent slaking and disintegration, bonding, pressing, burning and storage. HFT (5)

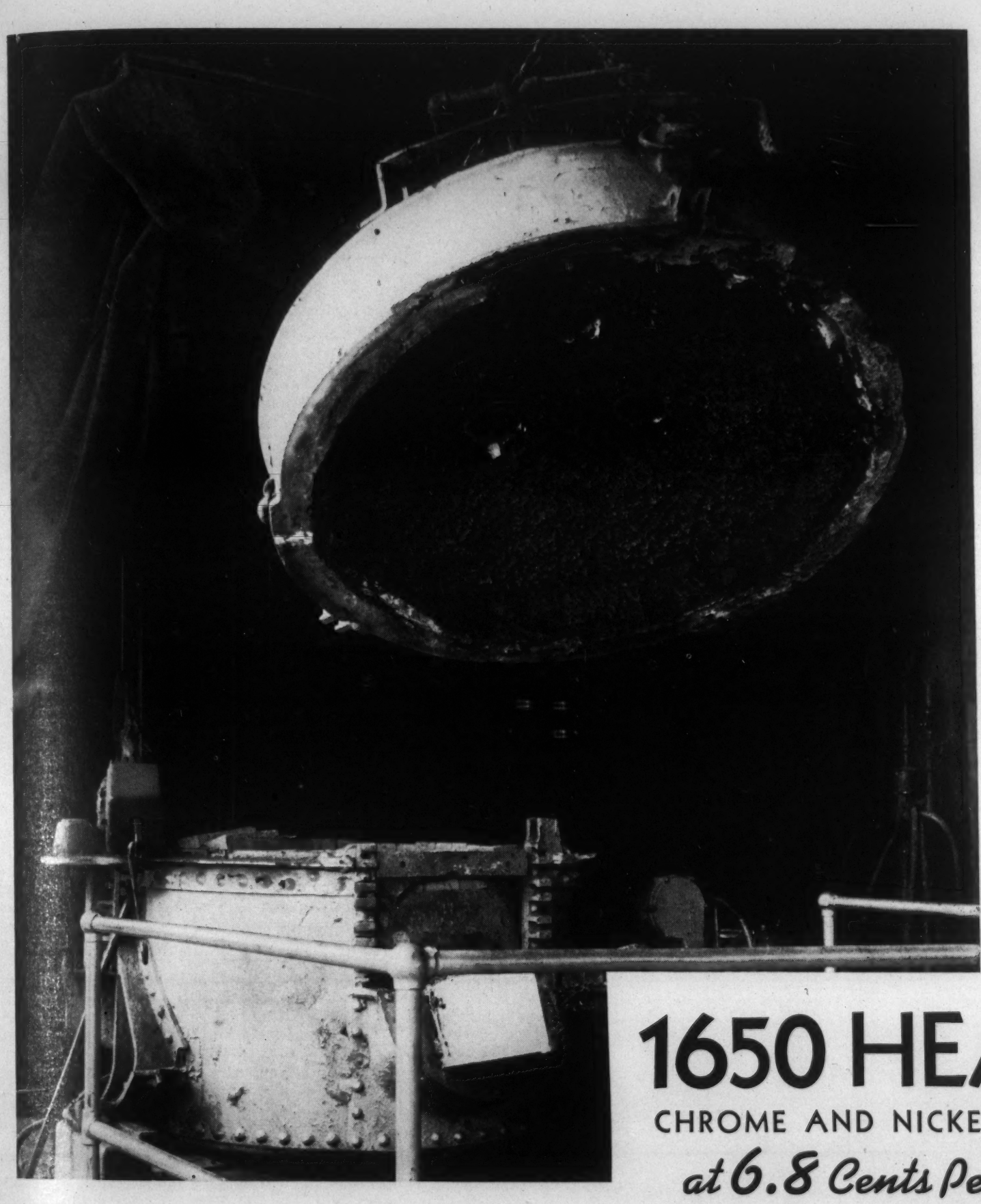
A New Theory of Recrystallization of Cold-drawn Metals. A. KRUPKOWSKI & M. BALICKI. *Hutnik,* Vol. 10, Dec. 1938, pp. 624-643. In Polish. *Rev. Mét.,* Vol. 36, Jan. 1939, pp. 21-29. In French. Research. Based on the changes during heating at increasing temperatures of (1) the thermoelectric force of cold drawn Cu; (2) the mechanical properties of cold drawn Cu; and (3) the magnetism of cold worked Ni, the authors conclude that a metal partially recrystallized after cold work contains no intermediate phases, but is merely a mixture of the cold worked grains and of the recrystallized grains. There is only one temperature zone where the properties of cold worked metals return to their original values, in contradiction to other investigators who have found that the recovery of all properties does not take place at the same temperature. This variation is attributed by the present authors to the fact that the former work was not done on extremely pure metals. The first recrystallized grains that appear in this zone (which should be called recrystallization rather than recovery zone) are too small to be detected by X-rays. After the recrystallization is completed, the grains grow to a size that can be distinguished by X-ray. JZB + JGT (5)

Annealing in Controlled Atmosphere (Glühen in Schutzgasen) *A-E-G Mitt.,* Mar. 1939, pp. 147-149. Practical. Controlled atmosphere can be obtained cheaply by incomplete combustion of city gas, propane, or ammonia. A mixture of 1 part city gas with 2.5 parts air gives an atmosphere that costs 1.7 pfennigs per m.^{3} (with city gas costing 5 pfennigs per m.^{3}). Gas made from propane (1:18 mixture) costs 7 pfennigs per m.^{3} (70 pfennigs per kg. propane) and gas made from ammonia (1:3.25 mixture) costs 18.6 pfennigs (65 pfennigs per kg. NH_3). The composition of the controlled atmosphere is 7% CO_2, 9% CO, 10% H_2, 72% N_2, and 2% H_2O from either of the first two gases, and 10% H_2, 88% N_2, and 2% H_2O for the last. The article does not discuss gases from coal, coke, and charcoal, which require elimination of dust, sulphur, etc. Photographs and drawings are shown of generators for controlled atmospheres from city gas and ammonia and of furnaces for different applications. JMN (5)

5a. Ferrous

O. E. HARDER, SECTION EDITOR

Annealing Cold Rolled Strip. *Iron Age,* Vol. 143, Feb. 2, 1939, p. 45. Practical description of improved strip annealing installation of Electric Furnace Co. Clean, scale-free work is possible, owing to the airtight construction of the furnace. Ordinarily used at temperature of about 1750° F., the temperature may be varied according to normalizing procedure most suitable to requirements of various types of strip. Temperatures of 2000° F. are possible. Furnace is rated at 275 kw. and designed for continuous bright production of 2000 lbs./hr. of strip heated to 1750° F. VSP (5a)



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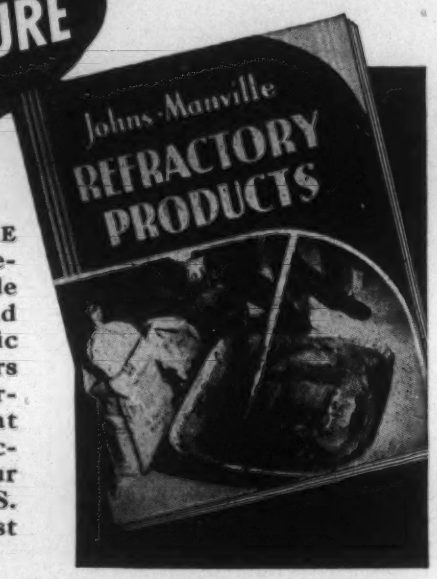

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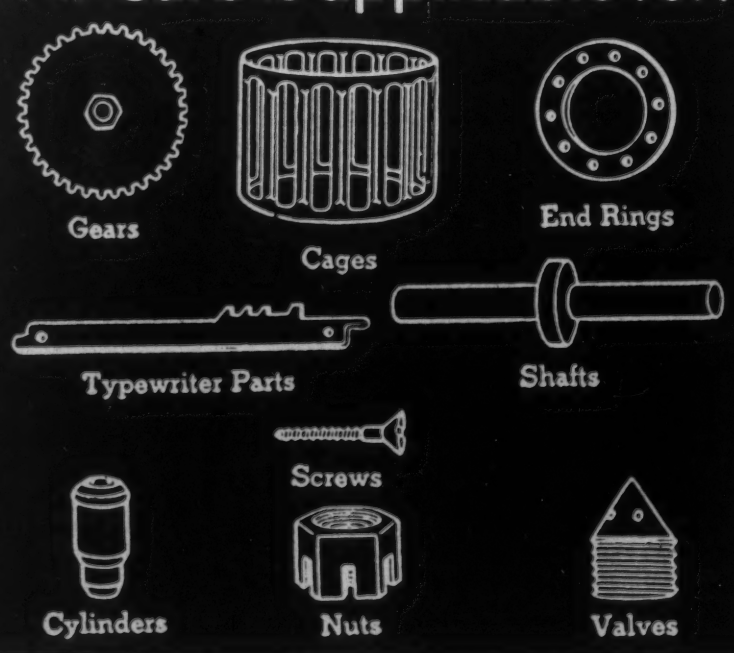

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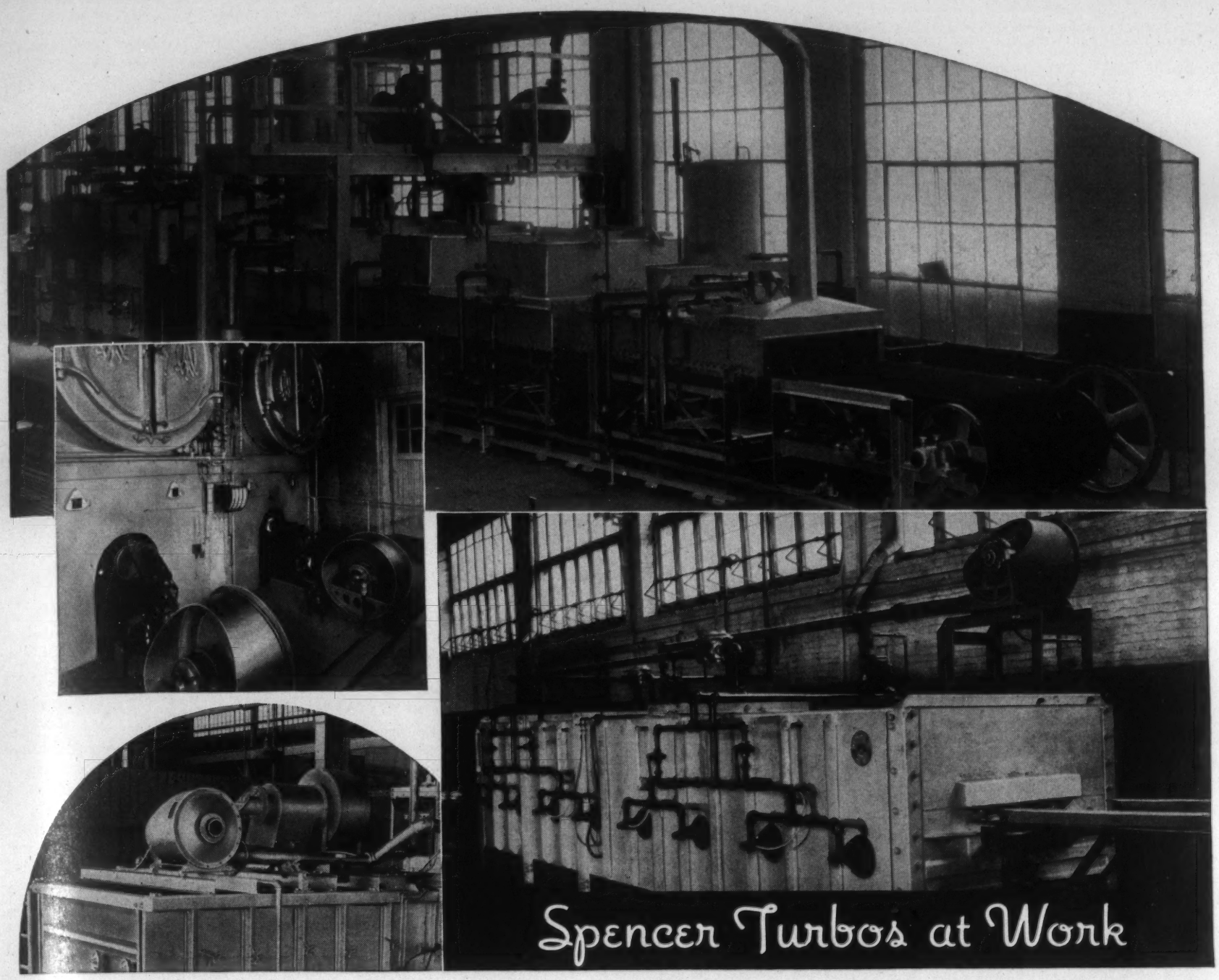
Carbon Linings for Blast Furnaces. FELIX SINGER. *Metals and Alloys,* Vol. 10, Apr. 1939, pp. 105-108. Descriptive. In America and generally in Europe, blast furnace linings are made of high alumina refractory bricks, or of fire-brick of "blast furnace quality". Recently, interest in the use of refractory *carbon* bricks for certain portions of the lining has grown, particularly in Germany, because of certain technological advantages that offset the evidently higher price. The carbon bricks are made from 5:1 coke-tar mixtures by steam heating, ramming or pressing, and burning in specially constructed kilns. In the blast furnace, such bricks react neither with the slags nor with the alloying constituents in the pig iron. Nor does the molten iron absorb C from the brick, for pig iron is already saturated with C and can take up no more. The thermal conductivity of C brick is 15-20 times that of fireclay. Carbon bricks have higher refractoriness, resist softening under load better than fireclay, and permit reduction of the number and length of joints in the lining. The C bricks, after being built in, are covered with a thin layer of fire-brick slab to protect the lining against oxidation at the start; even when base, hearth and bosh are made of C blocks, the parts around the tap hole must be masoned in fireclay blocks. Blast furnaces lined with C bricks and kept running for 5-6 yrs. attained an output of 1,000,000 tons of pig iron per life of the furnace. Just what comparative advantages would accrue to American blast furnace operators through the use of C linings cannot be determined, because of the very high grade of American flint-clay-bearing firebrick. In supplementary comment (p. 133) F. J. VOSBURGH states that one German furnace has actually produced 3,000,000 tons from one C lining, that no cooling plates are used in any C-lined part of a blast furnace, and that, in addition to Germany, Russia and Sweden, C linings are used also in Belgium and Italy. FPP (5a)

Circular Annealing Covers. J. L. WHITTEN (Lee Wilson Eng. Co.) *Steel,* Vol. 104, Mar. 20, 1939, pp. 52-54. Describes installation of circular bell-type annealing covers by Superior Steel Corp., Carnegie, Pa., for annealing wide and narrow strip steel in coils. There are 3 radiant-tube, gas-fired furnaces, each with 3 bases and capable of holding coils stacked 84 in. high and of a diameter up to 45 in. Average charge is 16,000 lbs. Inner cover is placed over charge in a liquid seal on base. The furnace that is placed over load and inner cover has 12 vertical alloy steel tubes, 4½ in. outside diameter and 6 ft. long, all equidistant from charge, and is fired with gas at 12 lb. pressure entering tubes at bottom end. Average charge of low-C steel is completely and uniformly annealed in about 16 hrs. Furnace is then lifted and moved to another charge. Complete cooling to 250° F. takes about 24 hrs. more. To expedite cooling portion of cycle, H_2O sprays are used after the first 12 hrs. of cooling. Recirculating fan in base moves gases under inner cover once every second. Atmosphere used is cracked natural gas, refrigerated to a dew-point of 45° F. Dual temperature control system is used. Fuel input is regulated first from tube temperature. Annealing temperature becomes controlling factor after steel has reached this temperature. Fuel consumption per ton of steel annealed is 985,000 B.t.u. First inner covers were of mild steel, but more recent installations are of 25-12 stainless steel. Results obtained are greatly increased uniformity in annealing and 50% lower annealing costs, compared with old in-and-out type furnaces. MS (5a)

Effect of Changed Conditions of Heat Treatment on the Mechanical Properties of Structural Alloy Steel. FELIKS TYCHOWSKI. *Hutnik,* Vol. 11, Jan. 1939, pp. 20-23. In Polish. Tests of mechanical properties of steel rods 1.2 in. in diameter and 20 ft. long, containing at the average 0.34% C, 0.53% Mn, 0.26% Si, 0.018% P, 0.014% S, 0.16% Cu, 0.77% Cr, 3.43% Ni, 0.31% Mo and 0.14% V, were made after the following heat treatments: Hardened at 830° C. and drawn at from 630° to 710° C., and (2) drawn uniformly at 650° but hardened at from 700° to 900° C. A rise in the hardening temperature brings about an increase of the ratio of the elastic limit to the tensile strength, while a rise in the drawing temperature within the limits investigated results in a definite reduction of this ratio. With constant temperature, the finest and most uniform structure was obtained at the lowest drawing temperature studied; with constant drawing temperature, the best structure was obtained at a hardening temperature of 870° C., as illustrated by 14 photomicrographs. JGT (5a)

Heat-treating before Machining. A. G. STURROCK. *Ind. Gas,* Vol. 17, Apr. 1939, pp. 7, 17. To speed up production of annealed and heat-treated cold finished bars of alloy steels with 0.35-0.55% C, the bars are completely heat-treated first and afterward machined to dimension so that distortions due to heat-treatment are automatically corrected. Although machining in the heat-treated state is a little more costly than in the annealed bar, this is balanced by the elimination of extra cost for corrections. The heat-treating furnace is described; the Brinell hardness of the heat-treated bars is about 300. Ha (5a)



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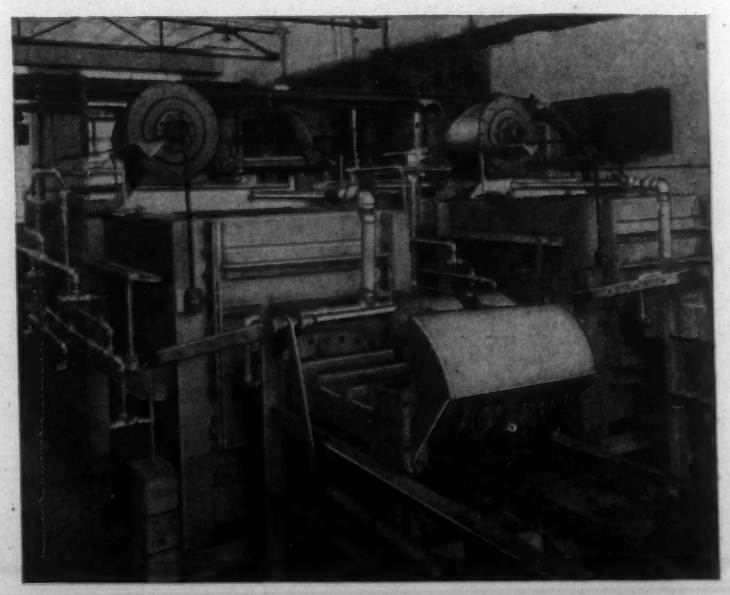

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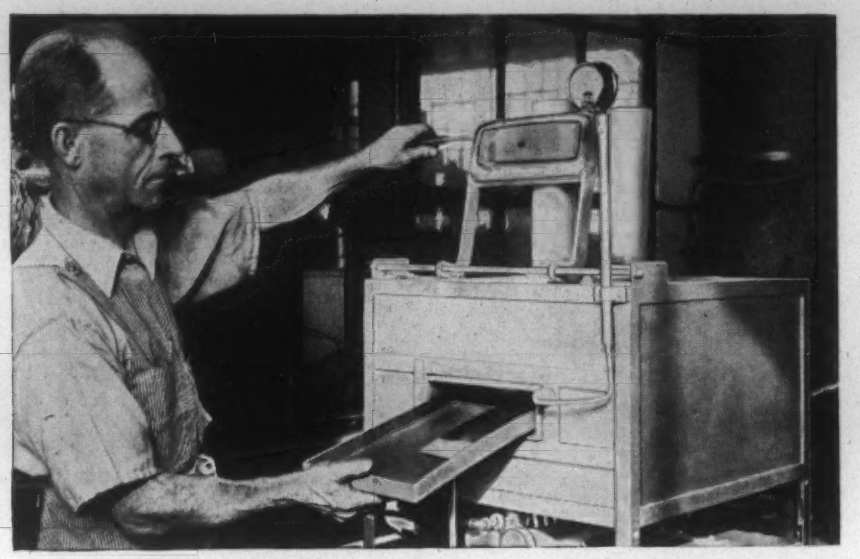

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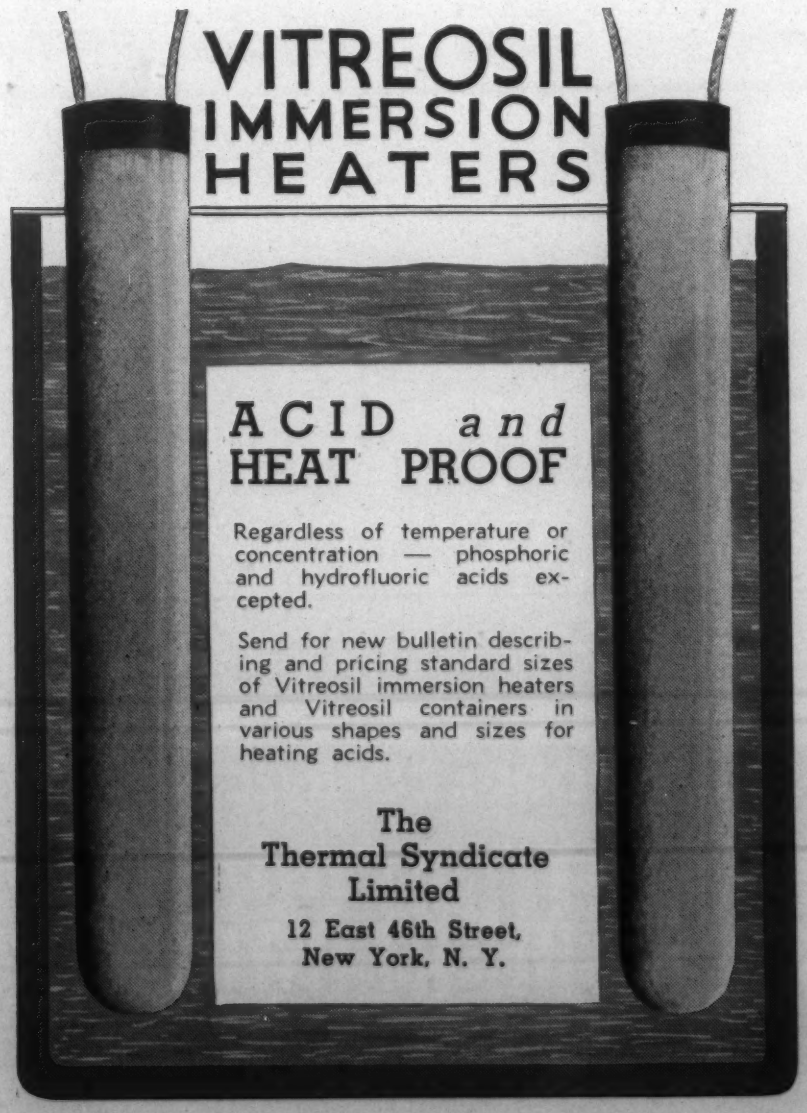

Carburizing and Heat Treatment of Chromium-molybdenum Case Hardening Gear Steels (Zur Kohlung und Wärmebehandlung von Getrieben aus Chrom- Molybdän- Einsatzstählen) HUBERT M. MEINGAST. *Durferrit Mitt.*, Vol. 8, Feb. 1939, pp. 25-47. The tests described were made to determine the simplest method of heat treating Cr-Mo case hardening steels. Notch impact tests and hardness determinations were made on steels that had been differently carburized and heat treated, and microscopic examination was included. Wear tests were made on certain finished parts. The carburization tests show that carburizing temperatures below 880° C. more easily lead to excessive carburization than temperatures above 880° C. In mild carburizing compounds carburizing can be carried out at 930° C. Technically and economically, carburizing in strong cyanide baths is free from drawbacks. The opinion that case hardening temperatures of 930° C. result in a sharp transition from core to case is unfounded. Quenching from such high temp. renders satisfactory results even if the grain is coarse. The results of notch impact tests on the steels used in the previous investigation heated at 930-950° C. for 1-10 hrs. and oil quenched show no significant decrease of notch toughness because of the time factor, and better values result than with samples quenched from 860 or 800° C. or samples refined by a subsequent second heat treatment. A subsequent annealing treatment leads to no further considerable increase of toughness. For previous installment, see also *Metals and Alloys*, Vol. 9, Aug. 1938, p. MA 487 R/3. GN (5a)

Continuous Strand Annealing. of Cold Rolled Strip. W. F. ROSS (Electric Furnace Co.) *Blast Furnace Steel Plant*, Vol. 27, Feb. 1939, pp. 193-194. **Continuous Strip Annealing.** *Steel*, Vol. 104, Mar. 6, 1939, pp. 58, 61. Descriptive. Equipment is designed for continuous parallel strands of strip 6-in. wide, or may be used for a single strip up to 30 in. in width and any number of narrower parallel strips within clearance dimensions of 30 in. Strip passes from unreeling apparatus through an entrance vestibule at charging end of furnace chamber and through an electrically heated chamber where it remains a relatively short time. Then it passes through a relatively long H_2O-coil type cooling chamber, in which its temperature is lowered gradually and uniformly throughout stock section. Heating and cooling chambers are filled with non-oxidizing products of combustion formed in a gas cracker. Strip then passes into a short chamber, adjacent to discharge end of cooling hood, where it is sprayed with H_2O at 190° F. and is thus quickly cooled to 200° F. This temperature is sufficiently low to ensure no discoloration upon contact of work with outer air, but allows sufficient residual heat to be retained to insure strips being dry and bright. Temperature in heating chamber is ordinarily 1750° F., but may be varied, with temperatures as high as 2000° F. possible. Heating chamber has 3 automatically controlled temperature zones. Equipment is rated at 275 kw. and 2000 lbs. per hr. MS (5a)

Controlled Annealing. RALPH M. DREWS (Republic Steel Corp.) *Steel*, Vol. 104, Mar. 20, 1939, pp. 62, 64, 73. Descriptive. Author's firm has installed new furnace of rather unique design and flexibility that permit production of very definite microstructures in high-C and alloy-steel bolt stock for cold heading. It is of bell-type design, about 9 ft. square, 10 ft. high, lined with 9-in. of fire-brick, and equipped with spirals of Cr-Ni heat-resisting steel radiant combustion tubes, 4 in. in diameter. Charge of 4000-6000 lbs. is lifted onto furnace base and is covered with a cylindrical, heat-resisting stainless steel heating cover 8 ft. high and 5 ft. in. diameter. Furnace is set down over charge, after it is sealed inside cover with sand. Cooling cover, similar to furnace frame but slightly smaller, is of steel lined with 6 in. of pressed insulating material. Natural gas is used for heating. Furnace is equipped with 2-point pyrometer control, one near the base and the other near the top. There are also 2 pyrometer controls in the charge, running the entire length. A reversible, variable speed fan in center of base distributes heat as required. The very even distribution and close control of heat achieved is most important, particularly in spheroidizing. Furnace facilities make available any rate of cooling needed to produce desired grain structure. On other types of furnaces, decarburization is as high as 0.020-0.025 in. Products of this furnace suffer no complete decarburization, and partial decarburization is held at 0.005 in. maximum. Non-oxidizing atmosphere produces a clean, almost scale-free surface. MS (5a)

Measurement and Control of Furnace Atmospheres. A. E. KROGH. *Can. Metals Met. Inds.*, Vol. 2, Mar. 1939, pp. 58-60, 62, 66. Practical. In the treatment of steel, one or several purposes in controlling the furnace atmosphere are evolved: (1) To eliminate scale completely, or simply to reduce it to a form that will be easily removable; (2) to avoid carburization, or to deposit C as a preliminary step in case hardening; (3) to avoid decarburization; (4) to produce a particular type of surface; (5) to introduce some gas into the metal such as N; and (6) to accomplish several of these purposes simultaneously. Types of furnaces for heat treatment are outlined, as well as the effects on steel of the special atmosphere. Tables show the effect of special atmospheres on heating of high speed steel, and some reactions

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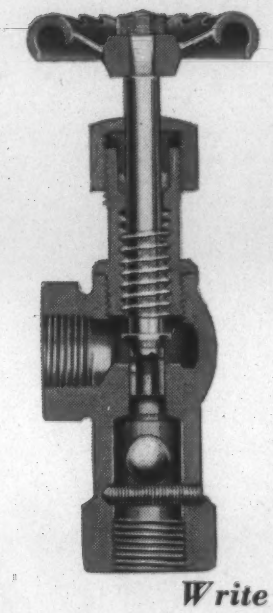

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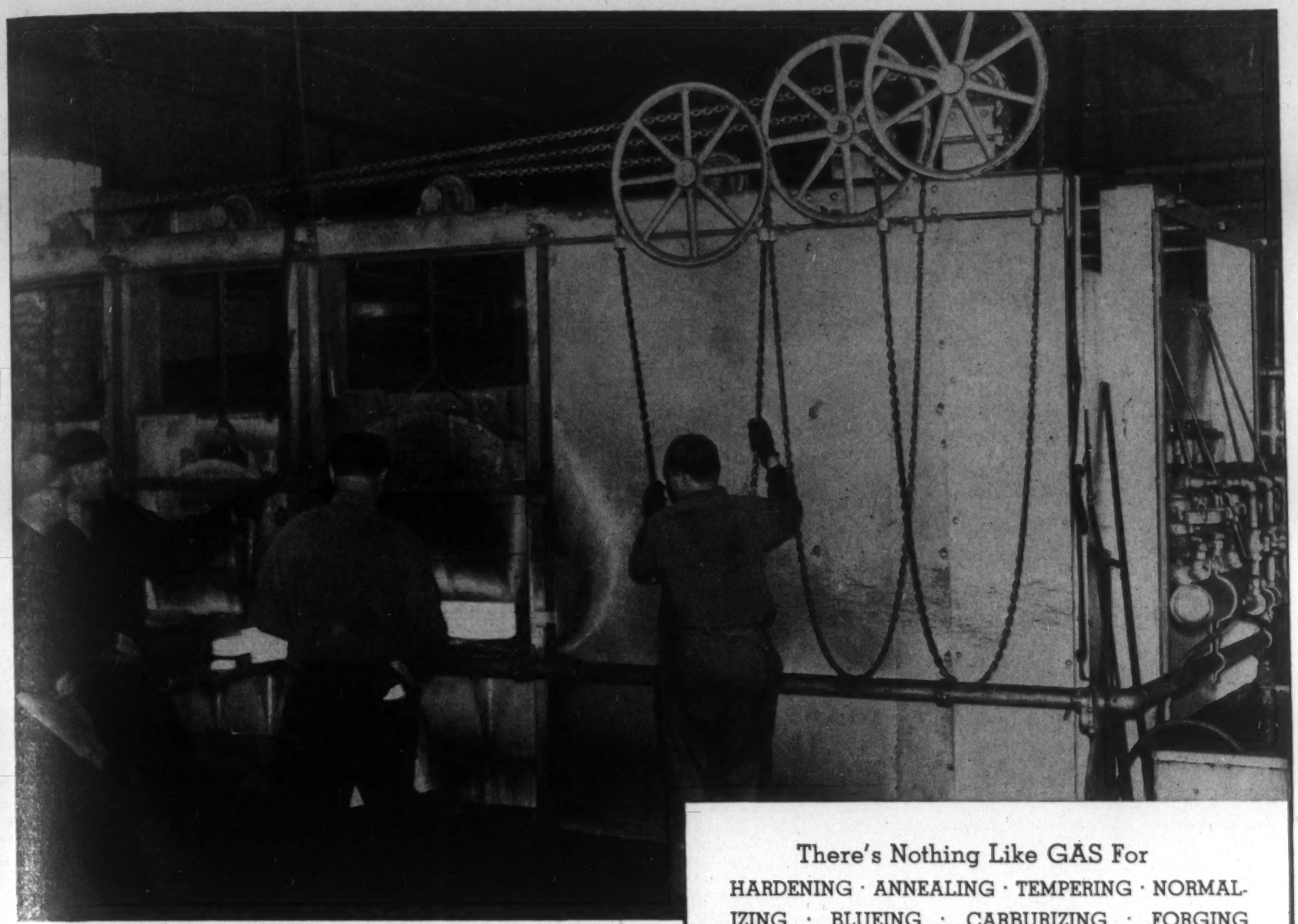
of some furnace gases with Fe, iron carbide and iron oxide and each other at elevated temperatures. Scaling is accelerated by the presence of sulphur dioxide. The influence at various temperatures of O, steam, carbon dioxide, and air on scaling rates is shown in a curve. Data are shown for studies of furnace atmospheres. In the case of water gas, scaling will always occur if the ratio of air/gas is more than about 2.5/1 and if no H is present. A thermal conductivity recorded is the best practical instrument for aiding in quick stabilization of the furnace atmosphere at the desired point. The instrument may be arranged for automatic control of the carburetor on a gas preparation machine, such as is used in sheet annealing work. WHB (5a)

Heating Rates of Steel for Various Operations. A. J. Fisher, Martin J. Conway, S. F. Maggs & T. A. Lewis. *Iron Steel Engr.*, Vol. 16, Mar. 1939, pp. 14-23. Practical. The heating of strip steel and tinplate products, because of their low C content, can be done in comparativaly short cycles. Uniformity of heating, accurate temperatures, and controlled atmospheres are important in the making of flat products. Defects from improper heating or furnace design are discussed. Heating rates of oil fired and gas fired furnaces on various sized materials are given in tabular form. Soaking pit heating rates for cold ingots are important; a heating rate of approximately 30 min./in. of ingot thickness allows sufficient time for the center of the ingot to reach the surface temperature of the ingot. Close control of furnace atmospheres is necessary to prevent excessive scaling. The ingot should be below rolling temperature when drawing schedules are upset due to mill delays. A low-S content fuel should be used. Observance of this practice gives lower metallic heating loss, lower surface defects and better physical properties. Improper rate of heating for processing alloy steels may cause cracking, distortion, excessive carburization or variation in microstructure and carburized case. The highest ingot stresses are set up on air-hardening steels where expansion due to martensitic transformation occurs even on slow cooling. Heating started at too high a temperature on this type of structure, would crack the ingot due to additional thermal stresses. High alloy ingots must be heated more slowly and longer than low alloy ingots. On high speed steel ingots heat absorption up to about 1200° F. for stress relieving takes place slowly; heating to 1380° F. must be slow enough for the transformation to take place, for improved ductility; heating to cogging temperature may now take place at a faster rate. Too rapid a rate of heating on large batch annealing of alloy steels just below the transformation range, may cause the outer portions of the charge to "drift" above the critical resulting in a variation in microstructure. Too rapid a rate of heating on large scale pack carburizing operations results in variations in carburized case. Forging practice covers a wide range of steel quality and shapes within the range of stock less than 1 in. diam. to ingots of over 100 in. diam. For plain C steel of 0.5% C or less, a minimum time of 5 min./in. diam. or thickness up to 3 in. is considered permissible. For steels having C higher than 0.5%, slower rates are used. Bars having 1% C and over 1 in. diam., should be preheated before placing in forging furnace. In C steels forging temperatures run to 2400° F. for very low C and down to 1900° F. for high C. Alloy bars and billets, with up to 0.6% C, may be heated at the rate of 6 min./in. diam. up to 3 in. diam. Slower rates are used on higher C steels or on larger sizes. Forging temperatures usually run from 2350° F. to 2200° F. depending on the C content. In high speed steel billet heating the rate of 1 in./hour is used, forging temperature is about 2150° F. Maximum time for preheating high speed steel ingots up to about 1600-1650° F. should be provided. From this point, up to the forging temperature (about 2150° F.) the heating time allowed is approximately half that of preheating. In heating large ingots for forging, when charged at an ingot temperature of 1000° F., the heating rates run from 5 in./hr. for the smaller ingots to 2 in./hr. for the very large sizes. The 1 in./hr. rule is followed if ingots are heated from a cold state. Flame temperature, flame radiation, brick radiating surface and degree of temperature uniformity affect the time for heating a forging to reach the proper working temperature. Importance of controlled atmosphere is discussed. Furnace used for heating special alloy ingots and billets for forging should be large enough for maximum production needs, but not too large for the lowest rate of firing from the standpoint of flame temperature uniformity and ability to maintain a proper furnace pressure and atmosphere condition throughout the heating range. CBJ (5a)

Annealing Stickers. *Steel*, Vol. 104, Jan. 9, 1939, pp. 41-42; Jan. 23, 1939, pp. 52, 54, 58. Practical discussion of the causes and details of practice which have been found to diminish the amount of sticking. Factors that cause stickers on cold-reduced stock are: Temperature, soaking time, pressure and surface finish. At some plants the annealing temperature was increased and time decreased without lowering of physical properties, and this reduced sticking. Sticking due to pressure may be eliminated by reducing



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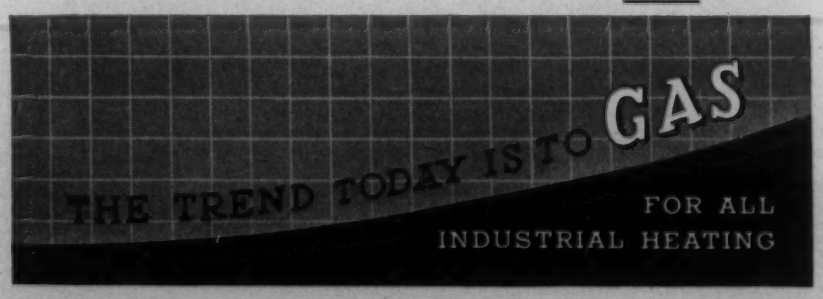

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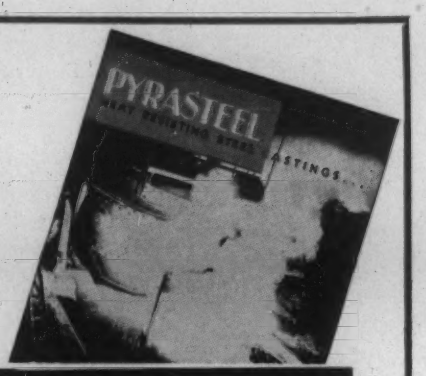

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height of pile of sheets. Pressures involved reveal that control must extend to each sheet or coil-wrap. Pressure operates differently in case of sheets than in coils. Control methods are focused on loading and piling in annealing furnace. Therefore, only flat and clean bases should be used; warped, cracked, uneven, dirty or wavy bases are poor foundations. Sheets should be piled evenly and uniformly. Gage and size of sheets must be considered; excessive crown in sheets requires lower piling. Sheets must be free of dirt, metal particles, tags, etc., and burred edges must be closely watched. Thermocouples must be inserted carefully in piles. In coil-annealing the tension used in winding must be controlled. Shape of strip off tandem mill is important. Coils should be spaced properly, and piled on end, never on sides. Allowance should be made for expansion by proper bundling. The smoother the surfaces are, the closer will be the contact between sheets or coils. Several control methods are considered. The most promising method is to apply a thin oil in which is dissolved a chemical. VSP (5a)

5b. Non-Ferrous

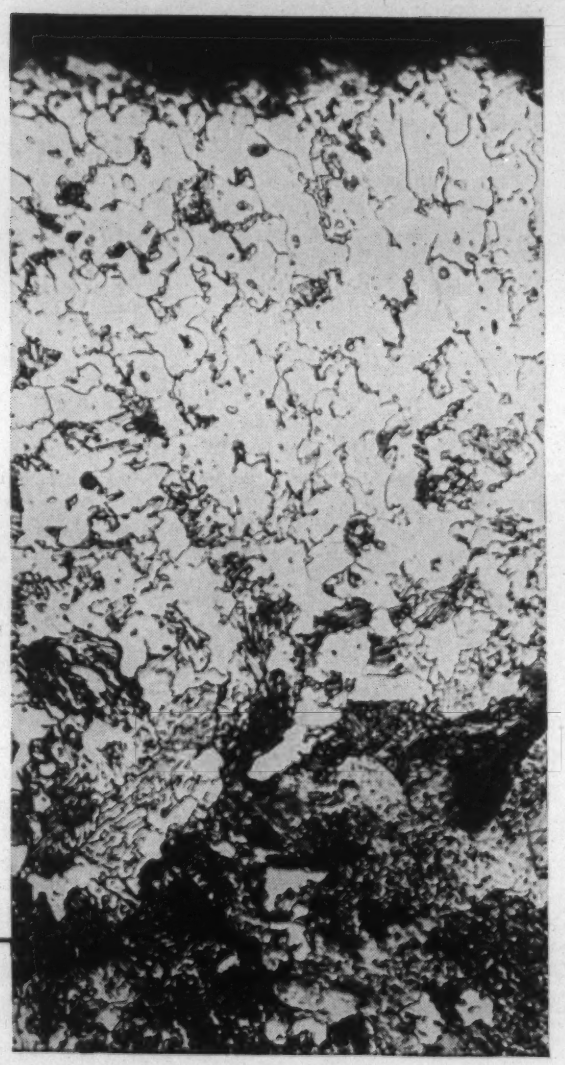
M. H. MAWHINNEY, SECTION EDITOR

The Influence of 0.5 to 1.1% Iron on Extruded Rods of Aluminum Alloys of the Al-Cu-Mg Type (Ueber den Einfluss eines Eisengehaltes von 0.5 bis 1.1% bei Pressstangen aus Aluminiumlegierungen der Gattung Al-Cu-Mg) A. FRY, W. WIEDERHOLT & W. BOEHME. *Z. Metallkunde,* Vol. 31, Jan. 1939, pp. 3-9. Experimental. Alloys of Al containing about 4.2% Cu, 0.7% Si, 0.8% Mn, 0.8% Mg and 0.5-1.1% Fe were cast into 200 mm. rods. These were extruded at 400° C. to 14, 25 and 49-mm. rods and annealed at temperatures from 450° to 540° C. and aged at room temperature for 4 weeks before testing. The Fe content had no influence on the tensile strength, yield point or elongation of the most severely deformed samples annealed below 500°. However, at higher temperatures, the alloys containing 0.86-0.98% Fe had poorer properties. Similar irregularities appeared between 490° and 520° for the 25-mm. alloys. The 49-mm. rods showed a change in properties with composition only when annealed at 500°. Independently of composition, the tensile strength and elongation increase with annealing temperature to 520° C. and then decrease. Up to an Fe content of 0.86%, the tensile strength decreased with increasing amounts of deformation; with more Fe, the amount of deformation has little effect. Under all conditions of composition and annealing, increased amounts of deformation decrease the yield point. The precipitate was finely distributed in highly deformed samples after annealing at 510°, but the precipitate was coarse in the other specimens. GD (5b)

The Recrystallization Temperature of Aluminum-copper Alloys (Ueber die Rekristallisationstemperatur von Aluminium--Kupfer-Legierungen) W. BUNGARDT & E. OSSWALD. *Z. Metallkunde,* Vol. 31, Feb. 1939, pp. 45-55. Experimental. The recrystallization characteristics of Al alloyed with up to 3.6% of Cu were studied by means of X-rays. The effects of pretreatment were the same for commercial Al-Cu-Mg alloys and for pure laboratory melts of Al-Cu. Room temperature aging did not influence the recrystallization temperature; however, full annealing before the final rolling lowered it, though high temperature aging had little effect. Grain growth after recrystallization was much less in the commercial alloys. The first changes of structure detectable by X-rays during heating were due to recrystallization for alloys with medium and high degrees of deformation, but with low degrees of deformation the intermediate $CuAl_2$ phase appeared first. GD (5b)

Ageing. MARIE L. V. GAYLER (Natl. Physical Lab.) *Metallurgist* (Suppl. *Engineer*) Dec. 1938, pp. 181-185. The following factors affecting age hardening are discussed: Quenching temperature, temperature of heat treatment, chemical composition, grain size, cold work including lattice distortion, quenching stresses and hydrostatic pressure. In reviewing current theories of age hardening, discrepancies in the "dispersion hardening" theory are pointed out. Practical applications and the need for further investigations are stressed. Grain boundaries, diffusion and cold work are the most vital problems in the study of aging. For Part I, see also *Metals and Alloys,* Vol. 10, Feb. 1939, p. MA 99 L/1. VVK (5b)

Electronic Structure of Certain Copper-aluminum Alloys (Structure Électronique de Certains Alliages Cuivre-Aluminum) JULES FARINEAU *Compt. Rend.,* Vol. 208, Jan. 16, 1939, pp. 191-192. Spectrographic studies in vacuo of a Cu-Al alloy containing 5.2% Cu were made at intervals of 2 months by means of the K_β X-ray due to the exterior or conducting electrons of Al and the ray L_α due to conducting electrons 3d and 4s of Cu. As aging proceeded, no change in the spectrum was found between order and disorder in the alloy, which means that the energy difference that takes place on aging is less than 0.1 electron volt. FHC (5b)



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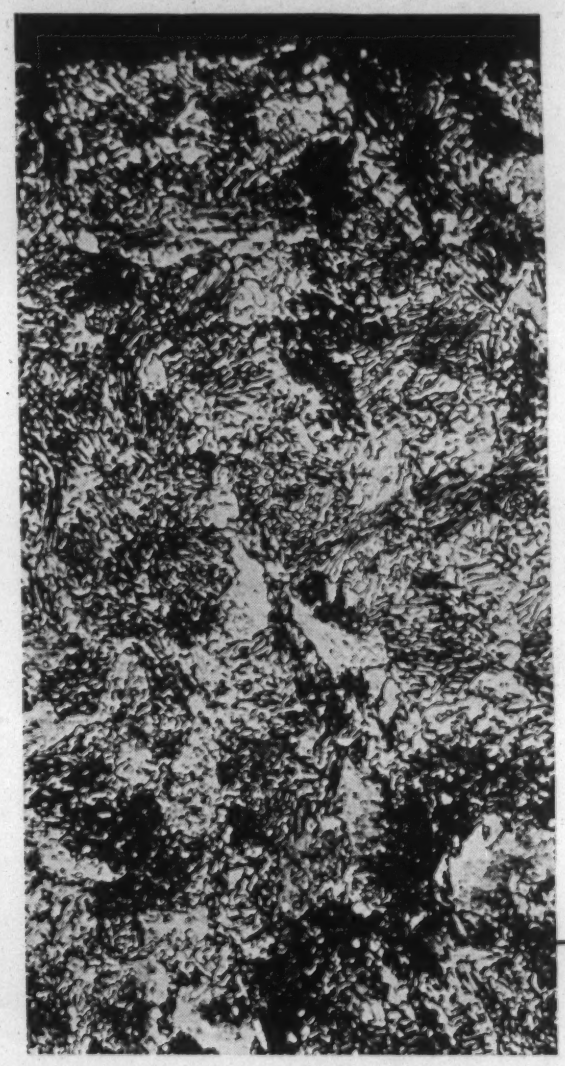

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Silver Brazing Alloys in the Marine Field. ROBERT H. LEACH & LEO EDELSON. *J. Am. Soc. Naval Engrs.*, Vol. 51, Feb. 1939, pp. 56-79. Review of joint design fundamentals and technique for carrying out procedures by a variety of methods. A discussion is given of the properties of the joint under elevated temperature conditions and also with respect to corrosion. Design of joint is of prime importance since the Ag alloys flow freely into narrow openings and exhibit their highest strength when small clearances are used. A few examples of poor and good joint design are given in sketches, and tabulated data give physical properties of different types of joint. Methods of applying the alloy are: (1) Hand feeding during brazing, (2) preplacing the brazing alloy either in or around the joint, or (3) providing a reservoir in which the alloy is placed before assembling. When the alloy is preplaced, the cost per joint is controlled without waste of the alloy, the joint is neat because no excess of brazing alloy appears, and operator control of brazing operation is more exact since he is relieved of necessity for feeding alloy to joint. A curve of strength of joint vs. thickness of joint for stainless steel to stainless steel indicates that maximum strength is attained at less than 0.003 in. thickness for plates butted on ends and brazed. The functions of the flux used in Ag alloy brazing operation are discussed, the indications being that the flux is chemically active in removing oxides from metal surface. The use of a flux, however, does not eliminate the necessity for thoroughly cleaning the metal surface before application of flux.
WB (6)

Progress in Soldering and Brazing. C. L. ASHBY. *Metal Ind., London*, Vol. 54, Jan. 13, 1939, pp. 77-81. Up-to-date review. Brazing is really soldering with a brass or other zinc alloy; soldering is joining the edges of less fusible metal by means of a more fusible metal. "Soft" and "hard" solder refer to low and high melting points respectfully. Bronze welding is modified brazing, done by filling a "V" butt, and copper brazing is in effect soldering with Cu. For many years there were three classes of solder; soft (Pb-Sn), hard (Cu-Zn), and silver (Ag-Cu-Zn-Cd). The art of silver soldering and of brazing by hand remains an indispensable legacy from the age of the craftsman, with its scope extended through the advent of new heating media and alloys. Ag-Sn, and Ag-Pb soldering alloys were developed for their higher melting points, for joining components of steam systems. Their strength is about the same as Pb-Sn but they are stronger at elevated temperatures and do not become embrittled, as do Pb-Sn alloys. Pb-Sn failures occur at low temperatures encountered in refrigeration but Ag-solders do not suffer this defect. Pb-Ag alloys are more resistant to corrosion than other solders. The lowest-melting hard solder runs at 605° C. Such solders find very useful application as joints can be made on Monel below the hot short range. Borax is the most universal flux for brazing and hard Ag-soldering, but does not become fluid at the low temperatures used with the new alloys, consequently lower running fluxes have been developed. Ag-Cu-P alloys find a limited use and do not require a flux when used on Cu. Such alloys are hard and brittle and not recommended for use on Ni or ferrous alloys. With the advent of the more rapid soldering methods, hand soldering is restricted to the smaller and intricate jobs. Solder powders are used with hand operated blow pipes for some of the less accessible joints or where attempts are made to standardize a soldering process. Here the operator has less control. There is difficulty, for example, in placing a large enough reservoir of solder at the joint. Also, the powder presents a larger surface hence greater oxidation and volatilization can occur unless the joint is well fluxed; if so protected the excess flux hinders coalescing. Inaccessible joints are better handled by placing soldering wire around the fluxed joint in assembling and then heating. Dip soldering is a process carried out by hand on a small scale, as in "tinning" the ends of wire before joining. A method for mass production has been developed by soldering in continuous belt furnaces, by use of Cu-Ag solder. Furnace heating of whole assemblies of course tends to affect the physical properties, so methods of applying electric heat locally have been developed. The thickness of the joint is not important if the solder is stronger than the metal joined, but this does not hold if the solder is strong but brittle; such joints are suitable only in lap joints subjected to shear over a large area. Silver-soldered joints appear to be stronger than brazed.
RWB (6)

Electric-furnace Brazing; When and How to Use It. H. M. WEBBER (Gen. Electric Co.) *Iron Age*, Vol. 142, Sept. 8, 1938, pp. 34-39. [First instalment of a 10-instalment series by the same author; other instalments are abstracted below.] Practical discussion of a comparatively new process and its advantageous applications. Reasons for using the process are: (1) Increased life of sub-assemblies and reduced costs; (2) strength at high temperatures; (3) uniform tightness; (4) little or no distortion; (5) good appearance; (6) high production rate; and (7) flexibility. **Holding and Supporting Assemblies in Electric Furnace Brazing.** Sept. 15, 1938, pp. 30-33, 62; Sept. 22, 1938, pp. 46-50. Stresses the importance and gives method and fixtures used for holding component parts of assembly together within furnace. **Electric Furnace Brazing: Capillary Attraction and Wetting Action Explained.** Nov. 3, 1938, pp. 30-35. Considers the value of understanding the basic phenomena of "creeping" and wetting. Applied near joints of assembly, the brazing metal first melts, then wets the parent metal and finally creeps into joints by capillary attraction. **Limiting Creep of Furnace-brazing Metals.** Nov. 10, 1938, pp. 44-46. Deals with methods of confining brazing metal to where it is wanted, and of removing excess Cu where limiting of creep is not practicable for various types of furnace-brazed jobs. Considers for the most part Cu as the brazing metal. **Applying Electric Furnace Brazing Metal.** Nov. 24, 1938, pp. 28-33, 65. Deals with the location, form and amount of brazing metal to be used. **Selecting of Furnace-brazing Metals and Fluxes (With Notes on Venting Hollow Bodies).** Dec. 8, 1938, pp. 48-51. Gives information on the selection of proper brazing metal and form in which it is to be applied. A brazing metal should: (1) Melt and flow at temperatures somewhat lower than the melting point of the parent metal; (2) wet the parent metal; and (3) be so placed that it will creep throughout joint. Includes list of metals that can be electric-furnace brazed and also a list of typical brazing metals and suggested fluxes. **High Strength of Furnace-brazed Joints Explained.** Dec. 29, 1938, pp. 30-34, 61. Properly made furnace-brazed joints have great strength, which, in case of Cu-brazed assemblies, is attributed to alloying effect between Cu and Fe and a knitting effect between the 2 Fe surfaces. **Furnace Brazing of Cast Iron.** Vol. 143, Feb. 2, 1939, pp. 55-57. Electric furnace brazing of cast iron calls for precautions usually unnecessary in case of low-C steel. Considers the possible causes of distortion of furnace brazed assemblies in general and includes an example of how strains from unequal expansion were overcome. **Factors Affecting Selection of Furnace-brazing Equipment.** Vol. 143, Mar. 16, 1939, pp. 30-35. Describes various types of furnaces and discusses influence of production rate, size of assemblies, cost of operation, maintenance and other factors in meeting individual requirements. **Remedies for Furnace Brazing Ailments.** Vol. 143, Apr. 6, 1939, pp. 46-48. Gives a condensed summary of what to look for and what to try if things go wrong, and in what instalment of this series of articles may be found remedies for furnace-brazing ailments.
VSP (6)

Application of Hard-surfacing (Overlay Welding) for Repairs and for New Work (Anwendung der Auftragschweissung für Ausbesserungsarbeiten und für Neufertigung) K. L. ZEYEN. *Tech. Mitt. Krupp*, Vol. 7, Apr. 1939, pp. 15-30. Practical. Wear of materials on places exposed to impact, abrasion, friction and pressure is repaired by overlay welding at these places; new parts are also hard-surfaced by welding-on layers of highly wear-resistant materials. A great number of examples illustrate the welding processes employed for producing hard, wear-resistant surfaces of Cr-Mn-Fe, Co-Cr-W and W-carbide in powdery and granular form. Preheating of the piece to about 600° C is of importance to get absolutely intimate joints. Sheets with up to 0.5% C can be satisfactorily gas-welded; with higher C content precautions must be taken to avoid cracks. Subsequent heat treatment is advisable. Gray iron can be welded also with the

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electric arc. Alloy cast iron should be treated like cast iron. The welding-on process can also be applied successfully on Monel metal, but brass, bronze and Cu offer difficulties because of their low melting points. The proper selection of welding rods and electrodes is discussed at length. Ha (6)

Brazing with Protective Gas in Continuous Furnaces (Hartlöten mit Schutzgas im Durchlaufofen) RUDOLF MIERISCH. *Tech. Blätter,* Vol. 29, Mar. 12, 1939, pp. 181-185. Review. Discusses the present status in this field in Germany, and considers preparation of work to be brazed, brazing alloys and their application, brazing procedure and subsequent treatment. The advantages of continuous brazing are given as decrease of manufacturing, inspection and maintenance costs; uniform physical properties and high tensile strength; resistance to vibration, shocks and high temperatures; density; small warpage and excellent appearance. GN (6)

6a. Ferrous

Coverings for Iron and Steel Electrodes in Electric Arc Welding (Sui rivestimenti degli electrodi di ferro ed acciaio per saldatura electtrica ad arco) A. REGÈ. *Met. Ital.,* Vol. 30, Dec. 1938, pp. 697-719; Vol. 31, Feb. 1939, pp. 69-84. Correlated abstract with 86 references. The simplest satisfactory electrode coverings consist of Fe_3O_4 or MnO_2. Each will permit fusion of the iron core, maintain the arc, and otherwise permit welding. Such welds have poor strength and usually contain non-metallic inclusions. Addition of feldspar and silica to such coverings leads to the formation of $FeSiO_3$, which readily dissolves oxide inclusions, thus giving much stronger welds. The fluidity of the weld may be further increased by additions of CaF_2 and $CaCO_3$. Na_2CO_3 also lowers the melting point giving a smooth weld, but it increases the viscosity of the slag markedly and is, therefore, not recommended. Additions of MgO or $MgCO_3$ render the slag very viscous and brittle, but they reduce the surface tension of the slag, and thus permit a good weld. Therefore small amounts of either of these compounds can be added advantageously. K_2CrO_4 increases the fluidity of the slag very markedly, making it possible to make welds very rapidly. This is of particular advantage when welding under surfaces. Na_3BO_3 or B_2O_3 also increase fluidity of the slag, but not so markedly as K_2CrO_4. TiO_2 in small amounts is also advantageous in special cases, as in welding Mn steels and stainless steels. A number of recommendations are made for electrode coverings for special purposes. For ordinary welds where strength is unimportant the covering may consist of 70 Fe_3O_4, 3 MnO_2, 1 CaF_2, 15 clay, 3 C, 3 $Na_2B_4O_7$, and 5% cellulose. For welds where strength is important the following covering is recommended: 33 Fe_3O_4, 15 MnO_2, 8.5 rutile, 25 clay, 10 Fe-Mn, 5 Fe-Si, 1.5 K_2CrO_4, 4% cellulose. For alloys, stainless steels and Mn steels the recommended covering is: 40 $CaCO_3$, 30 CaF_2, 5 SiO_2, 5 rutile, 5 feldspar, 6 clay, 5 Fe-Mn, 4% cellulose. AWC (6a)

Arc Welded Casing. G. M. STEARNS (Cities Service Oil Co.) *Oil & Gas J.,* Vol. 37, Jan. 5, 1939, pp. 52-53. Advantages of welding casing over threaded and coupled casing are: (1) The substantial saving that can be realized in the total cost of the pipe strings; (2) increased joint strength that makes possible the safe running of longer strings of pipe and results in less possibility of loss of pipe in the hole owing to failure of the string when under stress; (3) less possibility of leaks under high pressure conditions; (4) possibility of more complete recovery of pipe on abandoned wells, since with butt welded joints there are no couplings or similar projections on the outer circumference of the pipe to hinder pulling the string. The special tools used in running welded casing are described. Complete data and cost analyses are given on typical installations. The cost analyses calculated from the running of about 1100 feet of 10¾ in., 40.5-lb. casing gave the following savings for welded construction. If the oil company does its own welding, the net saving per 30 ft. casing joint is $7.44, corresponding to $0.2479 per foot of casing. If the oil company hires a job welder, the net saving per 30 ft. casing joint is $6.74, or $0.2247 per foot of casing. VVK (6a)

Welding Meets the Problems of the Heating Contractor. HORACE E. WETZELL (Smith & Oby Co.) *Ind. & Welding,* Vol. 12, Mar. 1939, pp. 28-31. Practical. With the standard practices set up today, and the availability of factory-made reducers, T-joints, welding ells, backing rings and other pieces, pipe line welding has been greatly simplified. For example, in one installation consisting of an assembly of 46 flanged joints bolted together, redesign for welded construction consisted of only 10 flanged welded joints. Pipe sizes were reduced 50%, and a 13% saving in steam was realized over the previous leaky system. Practically all pipe is beveled for a simple V weld with a 75° angle. In high pressure work, the usual backing ring is employed, the rings being of the same material as the pipe. CEJ (6a)

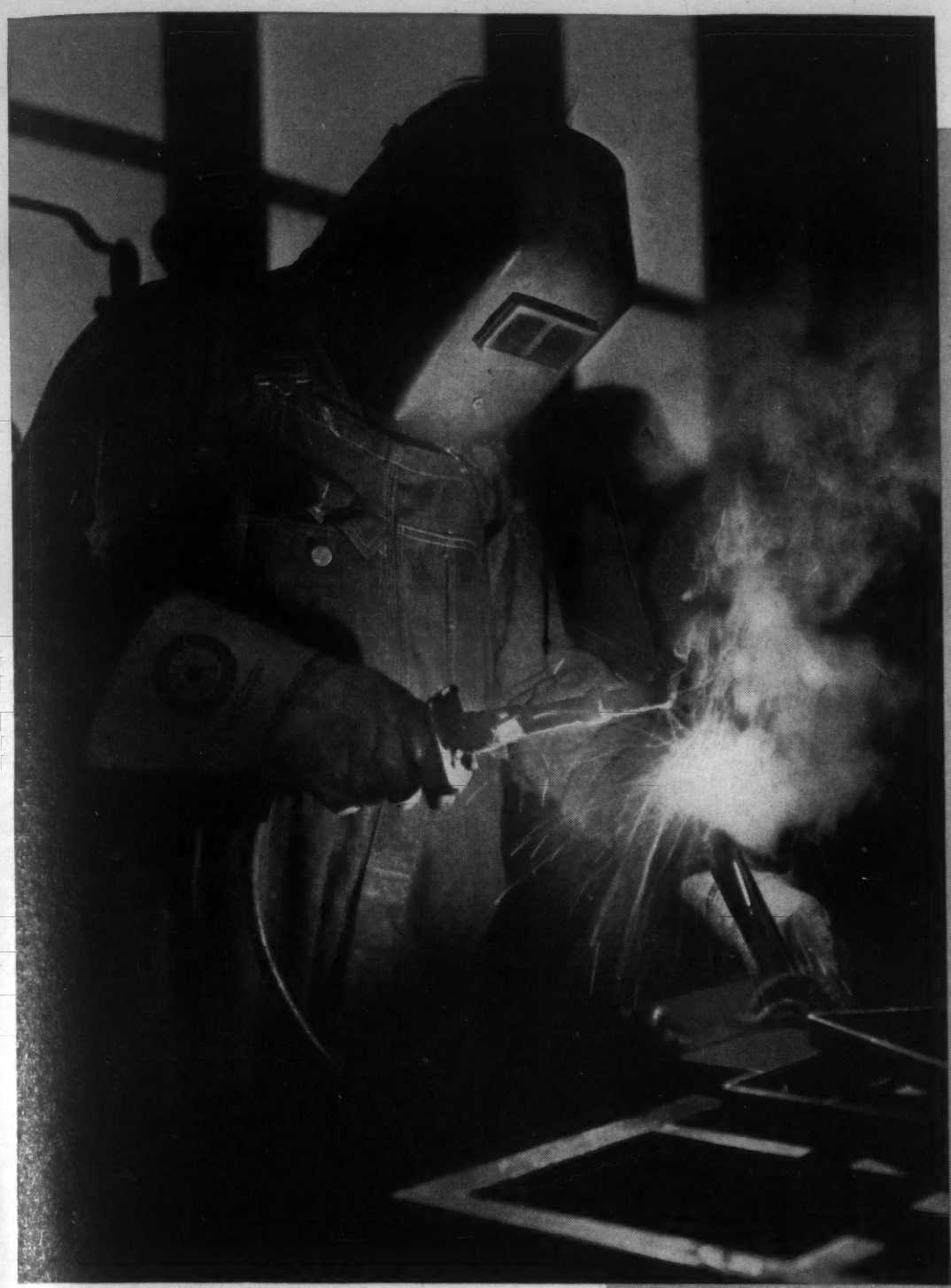
The Welding of High Tensile Structural Steel in Germany. E. H. SCHULZ & W. BISCHOF. *Inst. Welding, Quart. Trans.,* Vol. 2, Jan. 1939, pp. 3-12. Review of the history of development of St 52 steel, which was designed to give higher strength than St 37 previously used but with the same ductility. The use of alloys and maintenance of low C content of St 52 was the solution to the problem by German steel makers. The chemical compositions of the steels produced by various German producers are given tabularly. One structure made of St 52 by riveting showed early in its history the necessity of using a different chemical composition for the rivets, owing to excessive hardening of original St 52. Fatigue test results on polished bars of St 52 were higher than St 37, but when mill-scaled plates were tested in repeated tension, St 52 was no higher than St 37, indicating that the higher strength St 52 was more sensitive to notches. It is, however, considered safe in use where the preponderance of static to repeated stress is large. The application of welding to St 52 depended on providing suitable electrode material for arc welding. Bare wire electrodes are considered suitable where tensile strength of weld equal to parent steel is desired, which is based on the philosophy that ductility may be unimportant in a welded joint where bi- and triaxial stresses occur and failure may occur, as in fatigue, without measurable deformation. Cored and covered electrodes have been developed for welding the various St 52 analyses on the market; the physical properties are tabulated for the Mn-Si-Cu, Cr-Cu and Mo-Cu steel electrode materials. The composition of the parent steels of St 52 grade are also tabulated with mechanical properties, as specified by German Railroads. The properties of steels made by various producers are tabulated for parent metal and welded joint in as-rolled and normalized condition. The fatigue strengths of the welded joint in the as-rolled and normalized plate are the same, and the steels, as made by various producers, appear to have closely similar properties. A review is given of the work of researchers in Germany in developing welded designs of joints resistant to repeated tension and in repeated bending tests, which indicate that "welded girders, although not free from shrinkage stresses, have an equal if not higher resistance to pulsating tension than riveted girders." Experience with the steel St 52 in welding of structural members dictated setting maximum limits of 0.20% C, 0.50% Si, 1.20% Mn (to which may be added 0.30% Mn or 0.40% Cr or 0.20% Mo), 0.55% Cu, 0.060% P, 0.060% S (0.10% S + P). Minimum values for mechanical properties for thickness intervals to over 3 inches are given in a table for the above chemical specifications. The effect of preheat of 200° C. on the bend angle of the welded joint are shown for 2 steels as follows:

C	Si	Mn	Cr	Cu	Bend angle after welding: tested at 20° C.	Bend angle after welding: tested at 200° C.
.17	.39	1.00	.39	.73	43-58	134-150
.17	.64	.88	.67	.79	26-29	113-141

The same results can be obtained by post-heating after welding at room temperature. Research has shown that the bend angle of the welded specimens is increased when the steel is welded in normalized condition after rolling. Normalizing removes rolling stresses, and the internal stresses caused by welding can be better distributed. WB (6a)

Stainless Steel for Welded Pressure Vessels. GEORGE A. SANDS (Electro Metallurgical Co.) *Iron Age,* Vol. 143, Feb. 9, 1939, pp. 38-39. Practical discussion. Introduction of low-C austenitic stainless steels with addition of less than 1.0% of Cb or Ti, which is not susceptible to intergranular corrosion, has made fabricated stainless steel pressure vessels as readily available as vessels of ordinary C steel. To obtain maximum benefits, the stabilized steel should be compensated by the addition of austenite-forming elements, such as Ni, to keep structure wholly austenitic. Addition of from 1.0 to 2.0% Mn improves the hot working, forming and welding operations. Because Ti oxidizes readily, Cb-bearing welding rods should be used. In addition to Cb (8-10 times the C content in deposited metal) about 2% Mn and 0.70% Si are recommended in rod composition. Gives brief description of an all welded tank car made from low-C austenitic steel of 18-8 type. VSP (6a)

Welding of Gray Iron (Das Schweissen von Grauguss) C. STIELER. *Giesserei,* Vol. 26, Feb. 24, 1939, pp. 82-88. With sufficient attention to the characteristic properties of cast iron, the latter can be welded with best results both by the electric arc and oxyacetylene flame. The piece (in its entirety, if possible) must be slowly preheated to about 600°-700° C. and very slowly cooled after welding. Welding rods should be cast iron of 3-4% C, 3-3.8% Si, 0.5-0.8% Mn, 0.4-0.8% P, and less than 0.1% S. Calcined soda should be added to dissolve oxides. Electric welding is also used, employing bare or coated steel electrodes, as cast iron electrodes do not give a joint. Owing to the local heating and consequently quick cooling, the weld becomes very hard. Practical instructions for correct procedure with gas and electric welding are given, with examples. Ha (6a)



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The Development and Progress of Welding in France. LISE BLOCK-SÉE. *Inst., Welding Quart. Trans.,* Vol. 2, Jan. 1939, pp. 13-27. A review in which 4 phases of development are discussed: (1) General scientific research; (2) applied research, (3) examples of French welding applications, and (4) inspection methods. Under (1) are listed the investigation of spatial temperature distribution of various flames and spectral analysis of flames used in welding, showing existence of OH and H_2 molecules in envelope. The atomic H flame was shown to be oxidizing at the tip of the cone used for welding, thus explaining the presence of certain oxides in welds made by this process. Chemical investigations include corrosion studies to determine effect of composition, welding method, etc., which indicate that there is little danger of electrochemical action. Other research is on micro-chemical methods of determining the chemical heterogeneity produced in the weld metal and adjacent parent metal by the welding process. The micro-chemical method has been applied to studies of major segregation and in certain cases to dendritic segregation. Studies are being made on welds with the Chevenard micro-mechanical testing machine in conjunction with microchemical analyses. The effect of N_2 absorption in arc welding, P in arc and gas welding owing to electrode coatings, PH_3 in acetylene and N_2 in atmosphere, and O_2 absorption in gas and arc welding are being investigated. The research developments are cited in the improvement of weldability of certain steels and the application of gas welding to steels heretofore difficult to weld.

WB (6a)

The Causes of Welding Cracks in Aircraft Steels (Ueber die Ursachen der Schweissrissigkeit bei Flugzeugbau-Stählen) O. WERNER. *Arch. Eisenhüttenw.,* Mar. 1939, pp. 449-455. Review plus original research. A series of sheets 0.75-1.5 mm. thick of steels of 0.20-0.50% C, 0.010-0.039% S, 0.19-0.34% Si, 0.46-1.40% Mn, 0-1.15% Cr, and 0-0.46% Mo, was gas welded. On the basis of observations and a review of the literature, the following conclusions were drawn: Welding cracks become visible at about 700° C. in the zone directly adjacent to the welded seam. With constant C content, the tendency to cracking increases with the S content. The probability of cracking decreases with increasig melting temperature of the steel in the steel-making furnace. No definite effect of the temperature of the Ar_3 transformation was observed. No differences were observed between the elevated temperature tensile properties of steels that did and that did not tend to crack on welding. An attempt is made to associate the sensitivity to welding tears with the presence of small amounts of FeO and MnO (amounts as small as 0.01% O). This O is considered to react with H from the acetylene gas used in welding, setting up an internal pressure of H_2O vapor that disrupts the steel. A similar weaker effect produced by the formation of H_2S by the reaction of the S in the steel with H of the acetylene is also held possible. The mechanism is considered similar to the embrittlement of Cu by the reaction of H with O in the Cu to form H_2O vapor.

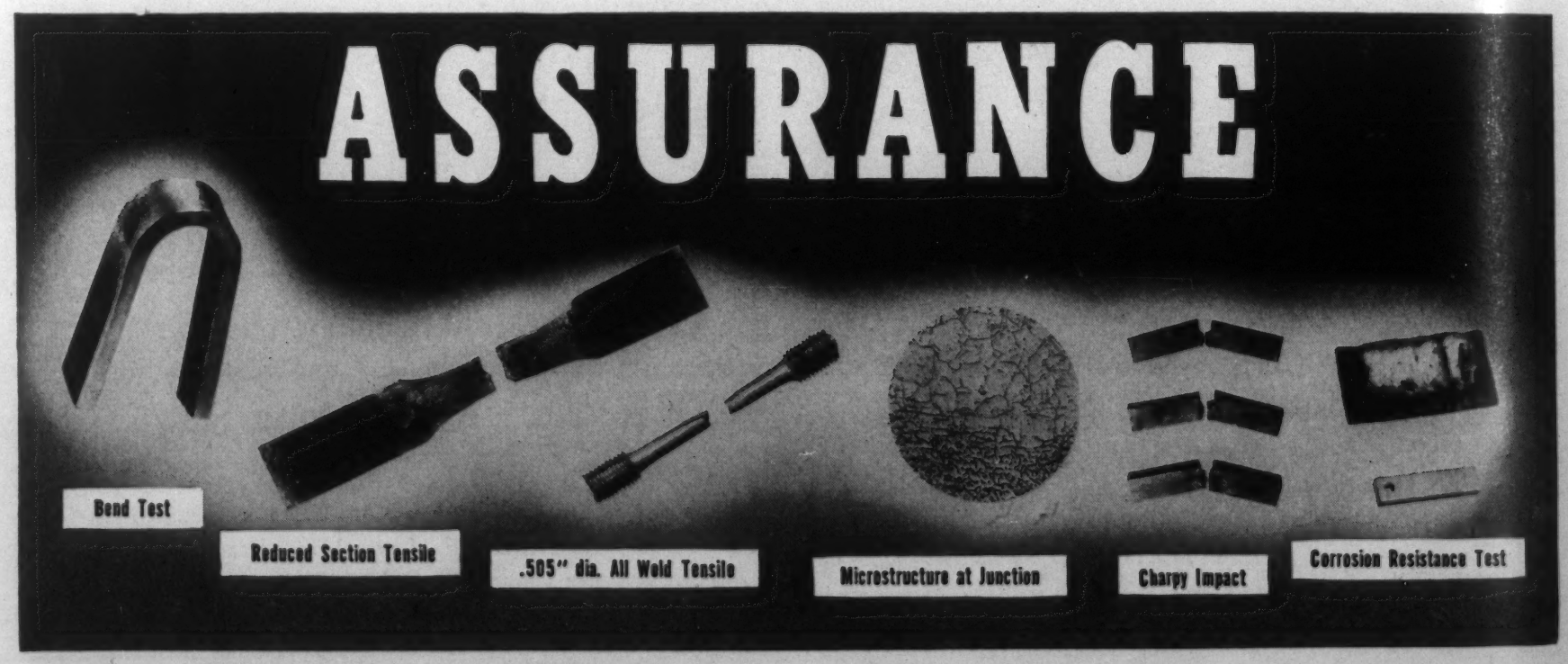
SE (6a)

Composites of Plain and Alloy Steels Produced by Carbon Arc Process. ROBERT E. KINKEAD. *Iron Age,* Vol. 143, Feb. 16, 1939, pp. 36-41. Practical description of a new method of making composite metals. Carbon arc welding is used in forming a stainless or other steel coating on the surface of a heated low-C steel ingot. It is then rolled down to clad material ranging in thickness from 3/8 in. to No. 20 gage. Advantages of composite metals may also be applied to composites such as medium C and plain steels, which may be used in the construction of weld-fabricated machinery. Includes photomicrographs and a table showing typical analysis data on surface alloyed slabs.

VSP (6a)

6b. Non-Ferrous

Present Status of Fusion Welding of Aluminum Alloys (Der derzeitige Stand der Schmelzschweissung von Aluminiumlegierungen) E. VON RAJAKOVICS. *Autogene Metallbearbeit.,* Vol. 32, Mar. 15, 1939, pp. 85-89; Apr. 1, 1939, pp. 101-106. Review. The several types of Al alloys that are today commercially utilized are surveyed and their properties described briefly. It has become possible to develop welding processes for all of them; gas-fusion welding is most often applied, with the resistance welding, electric arc and the Weibel processes frequently used also. The last named process was recently developed in Switzerland and is suitable for welding of sheets of 0.2-1.5 mm. The edges of the sheets are slightly bent up 90° and butt-welded together by electrically heated carbon electrodes that are guiding along the edges so that the necessary heat is produced outside the metal; alternating current of 4-8 v. is used for heating the carbon electrodes. The correct procedures to be applied in each case are described in detail and testing methods for determining strength and corrosion resistance of the weld discussed. 12 references. Ha (6b)



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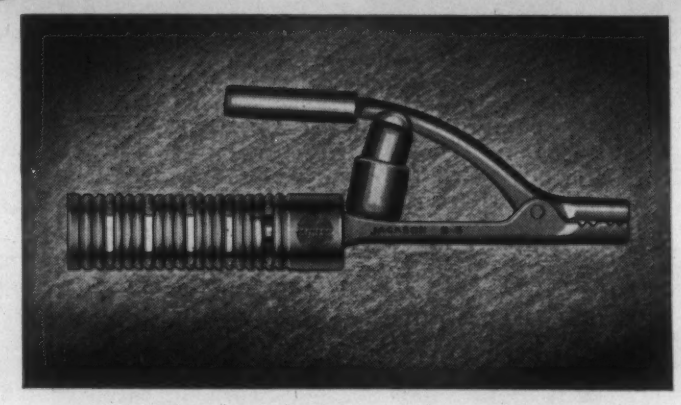

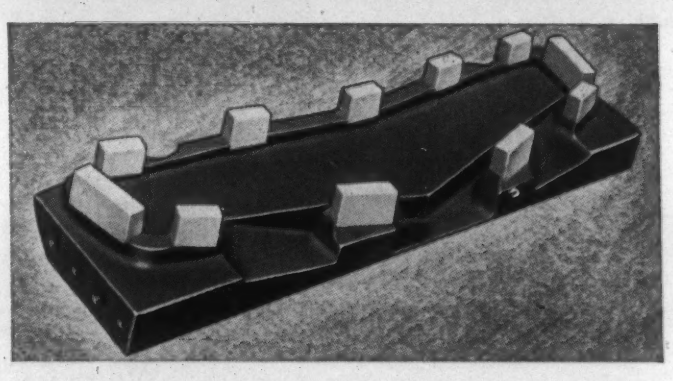

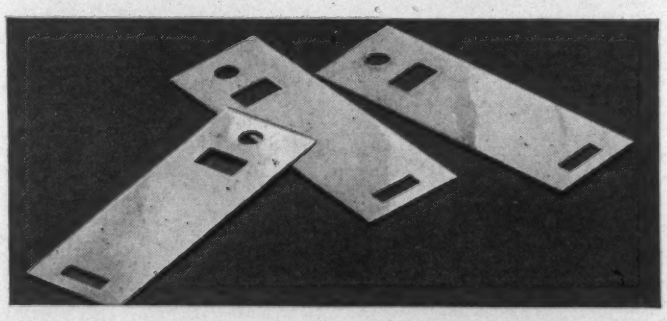

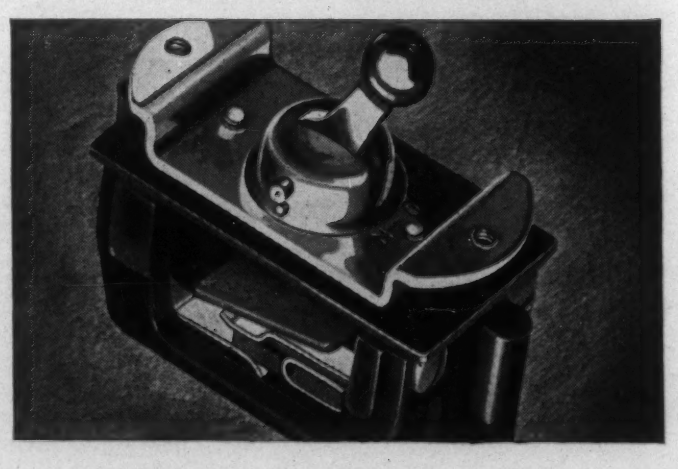

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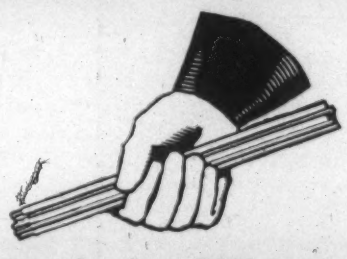

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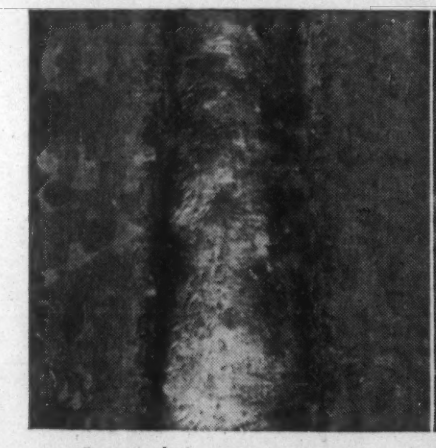

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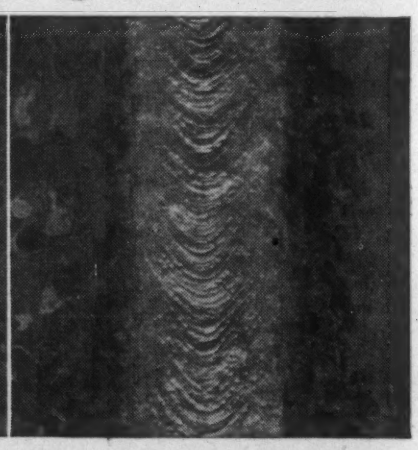

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Recent Advances in Resistance Welding. L. B. HUNT. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 69-73. Practical review. The spot seam, butt, and flash welding of Al, Mg, Cu and Ni and their alloys are discussed. Non-ferrous materials have much higher electrical and thermal conductivities and entail greater control than do ferrous metals; the higher conductivities also require heavier currents. Resistance welding machines are being designed with these differences in mind and are being widely applied to the non-ferrous field. The most important interest in resistance welding Al and its alloys is in the aircraft industry, where spot welding is replacing riveting. Spot and seam welding of Al alloys require adequate cleaning of the surface by either mechanical or chemical means. The electrodes may have either a spherical (England) or conical (8-10°) (U.S.A.) tip. Where corrosion is a factor care must be taken to eliminate Cu pickup. For this reason electrodes must be cleaned and redressed to ensure their holding correct shape. Cleaning is done by rubbing with fine emery held in the fingers but redressing must be done in a lathe; in no case should a file be employed. For Al, water cooled electrodes of precipitation-hardened Cu alloys are used. The actual operating condition for the successful spot welding of Al-alloys in terms of electrode pressure, time and amperage are difficult to state in general as the practice varies considerably among users. Spot weld strength compares very favorably with rivets when in shear or fatigue stressing but is somewhat inferior in tension. In seam welding it is essential to employ synchronous timing; liquid tight joints can be made in thicknesses up to 1/8 in. In the heat treated condition the seam will hold pressure. Flash welding technique is available for Al alloys; the operation is carried out as with steel, except that the current used is considerably higher, and in many cases the machine must be modified to provide a final upset based upon pressure rather than travel. The majority of the Al welding equipment will work equally well with Mg. Because it has a higher resistivity than Al, Mg requires a lower power input. Buckling causes difficulty in seam welding Mg sheet. By combination of butt and flash welding, extruded sections in Mg alloy may be successfully welded, but straight butt welding is not generally recommended. Cu has been spot welded in thicknesses up to 1/16 in., but considerable difficulty is usually encountered and poor strength properties are usually obtained. Seam welding is practically impossible. Sections of 3/4 in. in diameter may be butt welded. The relative ease with which the Cu alloy may be welded depends on the composition. Progress has been made in flash welding, particularly of bronzes containing appreciable percentages of Sn and Pb. Ni, Monel and Inconel can be spot and seam welded. Ni sheet in heavy gages and Inconel up to 20 gage can be flash-welded. If full and proper advantage is taken of up-to-date technique of resistance welding, by use of improved electrode and die material, proper planning, automatic methods, and machines of sufficiently high capacity, very marked economies can be effected in the production of non-ferrous metal articles, while high standards in both strength and appearance can be maintained. RWB (6b)

Fusion Welding Non-ferrous Materials. H. W. G. HIGNETT. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 74-76. Review. The characteristics of any material must be considered before any attempt to predict its welding behavior is made. The presence of Pb in brass or Ni silver makes these materials almost impossible to weld without risk of contraction cracking. Manufacturing history is seldom considered but the hot shortness of high Ni alloys is considerably influenced by deoxidation methods; the effect of the gas content is quite evident in Al castings; the importance of thermal characteristics is obvious. Arc phenomena have been studied; the Fe arc, unlike Cu and Al, starts from the small anode area, spreading out to the cathode, which explains why metal transfer is obtained with bare Cu and Al electrodes only if they are connected to the positive pole. All the properties of a metal that interest the foundryman are of importance in welding. Reactions occurring in a flame or arc constitute a separate problem for each material so it is difficult to establish general principles. In non-ferrous fusion welding there is a trend toward the freer use of oxidizing atmospheres. An interesting point is the increasing importance of Si-bronze as a welding material. A new method for welding thin Al sheet by turning the edge of the sheet up, coating with flux, and heating by applying two carbon electrodes one on each side of the flange, has been proposed. The use of an "arc-length monitor" is of considerable value for training operators and in improving the consistency of high grade welding. 16 references. RWB (6b)

Welding Lead Pipe and Plates. Types of Metal. Welding Equipment Methods. W. HERRMANN & W. FROLICH. *Can. Metals Met. Inds.,* Vol. 2, Jan. 1939, pp. 2-3, 9; Feb. 1939, pp. 32-33. A discussion of the autogenous welding of Pb, dealing particularly with the composition of the parts to be welded, the surface conditions needed and the correct apparatus. Pb plates may be lap- and butt-welded, while Pb pipe may be slit-welded, lap- and butt-welded, or flange welded. Pure Pb sections are welded without fluxes, while antimonial Pb parts yield better results if alcoholic pastes of salammoniac are used. WHB (6b)

7 Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

Surface Treatment of Light Metal Pistons (Oberflächenbehandlung von Leichtmetallkolben) E. MEYER-RÄSSLER. *Metallwirtschaft,* Vol. 18, Feb. 17, 1939, pp. 151-154. Review. This article is concerned mostly with the treatment of Al pistons, though some reference is made to Mg-base alloys. Surface treatment of light metal pistons has 2 purposes: (1) The production of a covering on the piston top to protect the light metal alloy, which melts between 500° and 600° C. from burning and cracking. For this purpose, high melting materials, such as Cr, Ni Cu, Ag, Fe and Al oxide coatings are suitable. (2) A covering on the skirt to improve running properties as well as to guard against erosion. For this latter purpose, low-melting soft metals, such as Sn, Pb, Cd and Zn as well as Cu, Fe and oxide layers (eloxal, anodized) are used. These coatings can be produced in a number of different manners, electrodeposition, immersion, metal spray, diffusion and cladding. For the protection of the top of the piston, no one process shows a definite superiority. Of the plated tops, those coated with anodically oxidized layers are better than no coatings, while Ni plate is better than eloxal coatings, with Cu plate being better than Ni. The immersion or galvanic processes give the best results on the piston skirt. Though coatings of Pb, Zn, Cd, Cu and Fe were tried, none proved as satisfactory as Sn-coated pistons. A comparison between the properties of eloxal coats and tinplate on the skirt showed the Sn coating to have all-around superior properties. No promising results have been obtained from coating Al pistons by the metal spray process or diffusion. The protection of the top of the piston is at present confined to racing cars and Diesel engines. Coatings on the skirts find universal application. GA (7)

The Protection of Metal Surfaces. T. P. HOAR. *Metal Ind., London,* Vol. 54, Jan. 13, 1939, pp. 83-89. A very comprehensive review of recent work. Statistical survey of available data shows that increase of Cu in steel from 0.02 to 0.2% increases the corrosion resistance 30-50%. Air-formed films on metals afford excellent protection in certain cases and it has been shown that the rate of thickening of a film on a metallic surface exposed to a tarnishing agent, may be related to the electrical resistance of the material of the film. Tarnishing is due to the electrolytic action in the short circuited cell, metal/film/tarnishing agent, with the film acting as both electrolyte and metallic connection. The rate of tarnishing at any instant is proportional to the total electrical conductivity of the film, and it thus appears that thin films of oxides and other substances having high electrical resistances should be able to give good protection. Hence impurities in an alumina or beryllia film would tend to lower the resistance. It has also been shown that by the selective oxidation of alloys containing small additions of Al or Be it is possible to produce films of pure alumina or beryllia on the alloy; these films confer remarkable protection from high temperature oxidation on Cu-Al alloys and from sulphides on Cu-Al, Ag-Al, Ag-Be, and Ag-Si alloys. Also it has been possible to deposit pure beryllia films cathodically on pure Ag very successfully. Determination of causes of defects in Sn and Zn coatings makes their cure a matter of technical development. "Transverse ripples" are due to vibration of the sheets in the rolls, "scruff" is caused by bands of $FeSn_2$ picked up from the rolls; "longitudinal ridges" occur where viscous liquids are spread by the rollers that they wet. The use of oxide-free Cu minimizes the "dewetting effect" in hot tinning of Cu. The best lustre in Zn coatings is obtained at a bath temperature between 440°-500° C. the immersion time varying from 2 min. at the low end to 10 sec. at the high temperature end. The most important criterion of a coating in giving protection from corrosion is the thickness. Bright Cr plate is obtained by using soluble Cr anodes with superimposed a.c. and d.c. in a chromic sulphate electrolyte. Tinplate can be used as a base for Cr. As good Ag coatings can be obtained from complex iodide baths as from the usual cyanide. Sn is successfully deposited from an alkaline stannate bath only in the absence of stannite. Sulphonated phenols retard oxidation in Sn baths. Bronze coatings from alkaline stannate/cupri-cyanide baths are excellent under coats for Cr. Zn on Al from a sulphate bath gives good protection. Difficulties in plating metals having resistant oxide films have been largely overcome. The thickness of a coating of sprayed metal needed for complete freedom from pores increases in the order, Zn, Pb, Cu, Al, Monel, Fe and stainless steel. Porosity can be reduced by annealing, hammering, or polishing the sprayed coatings. 150 references. RWB (7)

Electrolytic Cleaning, Especially Pickling of Metallic Objects (Elektrolytisches reinigen, insbesondere Beizen von Metallgegenständen) W. MACHU. *Korrosion u. Metallschutz,* Vol. 15, Apr. 1939, pp. 105-122. General survey. Of the different processes for cleaning metals, the electrolytic has advantages over the chemical in that the metal itself is not attacked by the cleaning fluid and practically no harmful gases are developed. Anodic and cathodic cleaning, pickling with alternating current and alternating polarity are discussed and described by a survey of the German, English, American, Austrian, French and Swiss patent literature. Data on composition and quantities required in cleaning and pickling baths are compiled. 39 references. Ha (7)

7a. Electrolytic Methods

Electroplating of Rustless Steel (Ueber die Galvanisierung von rostbeständigem Stahl) G. BUSS. *Mitt. Forsch. Inst. Probieramts Edelmetalle,* Vol. 12, Dec. 1938, pp. 83-91; Jan./Mar. 1939, pp. 98-105. Research. Electrodeposits on rustless steels offer the same difficulties as on Cr and on passive Ni—a tendency to spall, owing to the fine oxide film. Past efforts to remove the film and to overcome other difficulties are discussed, and recent experiments are described. Good Ag deposits were obtained (for cutlery and other decorative purposes) by first pickling in HCl solutions or by anodic pickling and then using intermediary layers of Fe or Zn, produced in acid baths; after this, Ag-plating is applied in the usual manner. An intermediate Cu layer of very good adhesion was obtained by dipping the steel in a high-Cu HCl solution. Best results were obtained with a content of 140-150 g. HCl and 1-5 g. copper chloride/l.; after 45-90 sec., a firmly adhering Cu film is formed. Increase of temperature (up to 80° C.) of the solution shifts the range of precipitation of the film to lower acid concentrations and gives less firm adhesion. Additions of Cr, Mn and Fe did not improve the Cu deposit, except 10 g. Mn/l., which after 1 min. produced a good, bright Cu film. It is, however, better to use an electrolytically deposited Cu film under Ag deposits, *e.g.* in a solution of 2 g. of Cu chloride in/l. of a solution of 225 g. HCl/l. water, with an addition of about 20 g. NaCl/l., to give more uniform deposits. Voltage of the bath is 1.5-2 v., current density 0.5-1.5 amp./dm.^{2} for ½-1½ min. The Ag deposit must be absolutely dense and free of pores. If this is not the case, galvanic corrosion of the base metal takes place, even under the action of environments that do not attack the ordinary unplated Cr-Mn steel. A table shows the potential differences of Cr-Mn steel against pure Ag in 5% solutions of NaCl, acetic acid, lactic acid, H_2SO_4 and in 1% lactic acid plus 0.2% NaCl. 12 references. Ha (7a)

Purifying Bright Nickel Solution. EDMUND S. JEVELI (A. S. Campbell Co.) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 26, Mar. 1939, pp. 196-198. Practical. The baths must be kept clean by filtration. The filter plates of the filter press should be covered with a precoat of filter-aid by passing a water suspension through the press. About 10 lbs. of filter-aid/100 ft.^{2} of filtering surface is required. Then 20 lbs. of activated carbon and 10 lbs. of filter-aid/100 ft.^{2} of filter surface are applied in a similar manner. The plating bath is treated with 5-20 lbs. of charcoal/1000 gals. of bath, before filtering. This filtering treatment removes oil, suspended matter and colloidal organic matter. Fe and Zn are removed from the bath by the usual method of raising the pH. Cu is removed by treatment with Fe powder or by electrolysis at a pH of 1-1.5, using a current density of 5 amp./ft.^{2} AB (7a)

Oxide Films on Aluminum. N. D. PULLEN. *Metal Ind. London,* Vol. 54, Mar. 17, 1939, pp. 327-329. Original research. The composition of oxide films on Al has been the subject of several researches, with rather contradictory results. An investigation was made into the structure and composition of films produced in chromic, oxalic and sulphuric acids. X-ray diffraction examination showed the film as formed to be apparently amorphous in each case. Some evidence showed the chromic acid film to be practically anhydrous alumina, while the oxalic and sulphuric acid films contained approximately one molecule of water per molecule of Al_2O_3. When strongly heated to temperatures of the order of 600° C., a strong γ-Al_2O_3 pattern was obtained. After boiling in water, chromic and oxalic films showed (X-ray) a distinct crystalline structure, while the sulphuric film remained unchanged. On ignition, if the loss in weight is calculated as water, the results obtained correspond to a bihydrate form. Chemical analysis of the chromic acid film, beyond Al_2O_3 and H_2O, showed nothing except a small quantity of Cr compound, equivalent to less than 0.1%. Oxalic acid films contained about 3% oxalic acid, and sulphuric acid films about 13% SO_3. The flexibility of the film may be expressed as: Flexibility index $= R^{\log x}$ (R is radius of curvature and x is film thickness). Chromic and oxalic acid films applied with a.c. are the most flexible, and sulphuric and oxalic acid films applied with d.c. are the least flexible. The actual amount of elongation the films can withstand is difficult to measure but is about 0.3-0.4%. This value can be obtained by direct measurement under special conditions and indirectly from the radius of curvature required to crack the film by using the relationship $E = d/2r$ (E is elongation, d the gage of metal, and R radius of bend). Hardness and flexibility are generally incompatible and films treated for maximum hardness have poor flexibility. Owing to difficulty in measuring, hardness results are more or less purely empirical and useful only for comparative purposes. The use of direct current, low temperatures, high electrolyte concentration and moderately thick films favors maximum hardness. Cold sulphuric or oxalic acid electrolytes normally give the hardest films. Anodized Al has important advantages for light compact insulation in view of its high heat resistance. The breakdown voltage of a film between 0.005-0.02 mm. is $A + bx$ (A and b are constants and x is film thickness). For thinner films, A is replaced by Ae^x. The breakdown voltage per mm. for normal films of average thickness is of the order of 30,000 volts and, by special impregnation, this figure can be greatly increased. RWB (7a)

The Electrolytic Deposition of Bright Metal Deposits (Die galvanische Abscheidung glänzender Metallniederschläge) M. WITTUM. *Mitt. Forsch. Inst. Probieramts Edelmetalle,* Vol. 12, Oct./Nov. 1938, pp. 67-75; Jan./Mar. 1939, pp. 105-111. Descriptive review. The economic advantages of producing bright deposits (elimination of polishing and consequent loss of deposited metal) are mentioned. The prerequisite of a bright deposit is a grain structure in which the individual grains are small relatively to the wave length of light which, in this case, is reflected directly; when the crystals are relatively large with respect to the wave length, the incident light is diffused and thus the surface appears matte. The grain size becomes smaller the lower the velocity of the growth of the grains and the higher the velocity of nucleus formation. This can be achieved practically by disturbing the normal growth of the crystallites by introducing alien bodies of a larger molecular size than that of the metal, *i.e.* colloids, either organic or inorganic. These conditions are exhaustively discussed and explained by micrographs of sections. A bright Ag deposit is obtained by addition to the usual cyanide baths of colloidal alkali silicates, or (USP 2,113,517) organic sulphides. Glue or gelatine is added to silver iodide solutions, but thiosulphate and ammonia (USP 2,110,792) are more practicable. Bright Cd is obtained from a cyanide Cd bath with 0.4 g./l. Ni, Co or Cu by adding aldehydes or ketones with ammonia, amines or alkali cyanides (USP 2,096,630). Bright Zn is obtained from cyanide solutions containing Cd between 8 and 20%, with additions of V, Mo, Mn, Re, Ni or Co. According to French Patent 804,587, thiourea (10 g./l.), alone or together with V, Mo or Mn (*e.g.* 7 g./l. MoO_3 at 1.6-7.5 amp./dm.^{2}) produces bright deposits. USP, 2,101,580 and 2,101,581 recommend synthetic resins for bright deposits. DRP 641,107 produces bright Sn deposits by addition of a synthetic, water-soluble resin from glue and cresol to acid Sn baths, or, according to Swiss Patent 185,429, 2 colloids from different groups. Addition of 0.1-0.01 g./l. Pb to Cu cyanide baths gives bright Cu deposits. Tl gives a similar effect, but the deposits are not quite so good. Cd, Ag, Zn, Ni, Co and Sn additions do not produce bright Cu deposits. Austrian Patent 148,698 recommends addition of colloids and capillary-active substances, *e.g.* α-naphthol. DRP 629,071 obtains bright Pb-Sn deposits from fluoboric acid solutions; they are brighter than the deposits of either of the 2 pure metals individually; the additions are alkali tartrates, caustic alkalis and glue (0.5 g./l.). Ni is the best known and easiest obtainable bright deposit; methods are described. Bright Co deposits are obtained by practically the same additions as to Ni baths; especially recommended is hydroquinon, formaldehyde and sodium hyposulphite; a good bath is 200 g./l. Co-ammonium sulphate, 10 H_2SO_4, 0.2 hydroquinon, 0.05 hyposulphite; or 200 g./l. $CoSO_4(NH_4)_2SO_4$, 30 ammonium acetate, 1 acetic acid, 3 formaldehyde, 0.2 Cd sulphate. Bright Cr deposits can be obtained only without additions and by definite operating conditions of the bath; the temperature must be above 40° C. Black Cr deposits are produced by very high current densities 60-100 amp./dm.^{2}, in a cold bath with not more than 0.05% H_2S and acetic acid. The hardness of the Cr deposits is largely influenced by temperature and current density. Methods for testing and comparing bright deposits are discussed. Ha (7a)

Filtration of Electroplating Solutions. WALTER R. MEYER. *Metal Ind., N. Y.,* Vol. 37, Mar. 1939, pp. 117-121. Survey. Adoption of the practice of filtering plating solutions has been slow, because of: (1) The readiness with which many of the old-time filters became clogged, (2) low filtration pressures of the old-time filters, (3) inability to justify the expense of the filter and the labor of filtration, owing to the low work productivity of cold, low current density plating solutions. Use of filter aids has reduced the frequency of cleaning and has aided faster filtration, higher pressure filters have been developed and wider use of warm plating solutions, higher current densities, thicker deposits and automatic equipment has stimulated the practice of filtration. The main sources of suspended matter in Ni solutions are: (1) anode smut which may consist of C, Ni or Ni oxide, (2) precipitated compounds of Fe, (3) dust from air especially if plating room is adjacent to the polishing room, (4) $CaSO_4$ from hard waters, and (5) $PbSO_4$ from reaction with Pb linings. Suspended matter definitely increases the porosity of Ni coatings and filtration markedly reduces the number of pores. A review of the construction and use of filters for electroplating solutions, particularly filter presses, is given. CBJ (7a)

A Study of the Alkaline Tin Plating Bath. SAMUEL HEIMAN & WALTER W. LUCASSE. *Metal Ind., N. Y.,* Vol. 37, Apr. 1939, pp. 161-164. Descriptive. The following bath composition is recommended for practical operation with filmed anodes: Sodium stannate 24.0 oz./gal., sodium hydroxide 2.0 oz./gal., operating temperature 75° C. This bath gives excellent white deposits. At an anode and cathode current density of 25 amps./ft.^{2}, the current efficiencies are each equal to about 80%. The bath can be operated satisfactorily over the current density range from 15 amps./ft.^{2} to 30 amps./ft.^{2} 7 references. CBJ (7a)

Plating Zinc Alloy Die Castings. A. W. WOLLBANK. *Metal Ind., London,* Vol. 54, Mar. 31, 1939, pp. 375-378. Review. The two chief difficulties encountered in plating Zn-alloy die-castings are rapidity of attack by plating solution, and porosity. When Zn die castings are to be substituted for brass or steel parts, redesigning is recommended—particularly, streamlining of the article in such a way that molten metal will flow through the die without undue turbulence. Zn alloys must be kept free from contaminations, as traces of Sn, Pb or Cd will promote intergranular corrosion. An alloy of 4.1% Al, 1% Cu, .03% Mg, remainder Zn is recommended. Die cast Zn alloys have a dense outer skin that should never be cut through in polishing. Strong alkalis can not be used in cleaning, and each cleaning operation must be brief. Once the alloy is wet it should not be allowed to pause at any stage until it is in the plating bath. A hot alkaline cleaner containing 3 oz./gal. sodium metasilicate, 2 oz./gal. trisodiumphosphate, at a pH about 11-12, is recommended. This is followed by a dip in dilute H_2SO_4, HCl or HF; the latter gives the best results. Originally a primary deposit of Cu or brass was used, but the present trend is for direct Ni. Single-salt Ni baths produce non-adherent Ni plate. To overcome this, a negative potential higher than the single electrode potential of Zn under these conditions is used. The tendency of Ni to deposit by immersion can be reduced by lowering the concentration of the Ni ions, which is done with 2 classes of salts: (1) Sodium salts of tartaric, citric and lactic acids and organic substances, such as triethanolamine; and (2) sulphates of Na, K, NH_4 or Mg. A typical direct Ni solution is: Nickel sulphate 12 oz./gal., boric acid 3 oz./gal., ammonium chloride 16 oz./gal. and operated at pH 6.0-6.2, 70° C. within the current density range of 12-25 amps./ft.^{2} The Ni deposit is fairly bright and easily finished and the process is well adapted to simple shapes. When attempting to plate difficult castings with plating solutions that must also be used for coating brass and steel, it is better to employ a primary deposit of Cu. The ordinary Cu cyanide bath is very satisfactory for this. The addition of Rochelle salts to the Cu solution allows the use of high current density at low free cyanide values, without causing excessive anode polarization. The Cu from this bath is a better undercoat for bright Ni. Ni-Cr and Ag finishes may be readily applied on the Cu plated articles, by treating them as ordinary Cu. The simpler sulphide bronzes can be applied directly on the Rochelle-Cu deposit. The true bronzes must be applied with caution. Either a thicker Cu or an intermediate Ni is desirable to guard against attack on the base metal. Brass solutions are usually as slow as the old type cyanide Cu. It is better to deposit brass on a Rochelle Cu primary deposit than to attempt direct brass plating. RWB (7a)

The Development of a Process for High Speed Copper Plating from Cyanide Solutions. F. F. OPLINGER (E. I. duPont de Nemours & Co.) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 26, Mar. 1939, pp. 181-195. Original research. The effect of plating conditions and bath composition on the anode and cathode current efficiency of the copper cyanide plating bath was studied. A high cathode current efficiency is obtained with a bath having a high Cu conc. and a low free cyanide conc. For example, a bath containing 140 g./l. of Cu, 5 g./l. of free NaCN, and 15 g./l. of Na_2CO_3 had an anode and cathode current efficiency between 95 and 100% at 30° C., for current densities between 10 and 20 amp./ft.^{2} The current efficiency decreases as the current density is raised, but by raising the temperature to 90° C., a cathode current efficiency of 90% was obtained with the above bath at current densities up to 100 amp./ft.^{2} Na_2CO_3 lowers the anode current efficiency, but at 90° C. it has little effect, even if 9 oz./gal. is present. The Dupont high speed Cu bath contains 60-90 g./l. of Cu, 140-210 g./l. of NaCN (12-18 oz./gal. of CuCN and 13-20 oz./gal. of NaCN) and 15-45 g./l. (2-6 oz./gal.) of NaOH. Temperature = 70-80° C. Wetting agents and brightening agents are also added, but their composition is not stated. In order to secure bright deposits, the cathode current efficiency must be practically 100%, as hydrogen evolution causes dull deposits. With this bath, current densities up to 100 amp./ft.^{2} (10 amp./dm.^{2}) can be used. AB (7a)

Water in the Plating Room. GEORGE B. HOGABOOM. *Metal Ind., N. Y.,* Vol. 37, Apr. 1939, pp. 165-167. Practical. Rinse tanks frequently become coated with a white sediment, especially after the alkaline cleaner, when hard water is used. Staining of electrodeposits can often be traced to the use of hard water for a rinse after the plating solutions since the precipitated salts dry on the work and cause stains. Precipitates on the surface prior to plating may cause pits, porosity and roughness in the deposit. In bright Ni plating, foreign matter carried in the rinse water before Ni plating may cause a slight cloud in the deposit. Presence of Cl in water may also cause difficulties, such as change in pH of the plating solution, polarization of the anodes and corrosion of tanks. Iron salts may cause pitted and rough deposits. The importance of the character of the water supply deserves emphasis, since in many cases water makes up 85-90% of the bath solution. CBJ (7a)

The Electrodeposition of Nickel from Nickel Chloride Solutions. W. A. WESLEY & J. W. CAREY (Internatl. Nickel Co.) *Trans. Electrochem. Soc.,* Vol. 75, 1939, Preprint No. 16, 22 pp. Original research. Nickel chloride baths, proposed for electrolytic Ni refining, have not been used for electroplating. The authors show that a nickel chloride bath has some advantages over the ordinary Watt's type nickel sulphate bath. A typical chloride bath contains:—$NiCl_2 . 6H_2O$, 300 g./l. and H_3BO_3, 30 g./l. At a temperature of 54° C., the bath may be operated at current densities up to 10 amp./dm.^{2}, and at a temperature of 66° C. current densities up to 20 amp./dm.^{2} may be used. The deposits from the chloride bath were finer grained than those from the sulphate bath and under the microscope did not show the columnar structure characteristic of deposits from the sulphate bath. Deposits from the chloride bath had less treeing and nodulation than those from the sulphate bath. The tensile strength was close to 100,000 lbs./in.^{2} or about twice the strength of deposits from the sulphate bath and the hardness of 230 (Vickers) is contrasted with a hardness of 150 (Vickers) for the deposits from the sulphate bath. The chloride Ni was less ductile than sulphate Ni and the porosity and corrosion resistance were about the same as those from the sulphate bath. The tank voltage required for the chloride bath was about ½ that required for the sulphate bath, because of its better conductivity. Another advantage of the chloride bath is its greater freedom from pitting. The chief disadvantage of the chloride bath is its greater corrosiveness. It corrodes Pb rather rapidly. AB (7a)

The Behavior of Cadmium and Arsenic in Nickel Baths (Ueber das Verhalten von Cadmium und Arsen in Nickelbädern) E. RAUB & M. WITTUM. *Korrosion u. Metallschutz,* Vol. 15, Apr. 1939, pp. 127-130. Research. Cd is added to Ni baths to increase the brightness of the deposits; the most favorable amount is about 0.07 g. $CdCl_2$/l. The Cd content of the deposit decreases at first rapidly with increasing current density, then more gradually. The appearance of deposits with predominating Cd content is always dull and has the characteristic Cd color; the deposits are soft and adherent. The alloy deposits with low Cd are bright, sometimes fairly brittle and show tendency to spalling. All other Cd deposits are spotty, grainy or spongy and do not adhere very firmly. In general, Cd is less suitable, as an addition to obtain bright Ni deposits than organic substances. Arsenic is added to improve brightness in brass plating, to retard the anodic attack on Fe in de-nickeling baths, or to obtain black Ni deposits. Great care must be used in its application because of formation of highly toxic AsH_3. The As content of the deposits is always higher than that of the bath; the Ni deposits become richer in Ni with increasing current density. The simultaneous deposition of As and Ni does not always follow the rule that the nobler metal is preferentially deposited. The cathode potential of the bath decreases with increasing As content, and the formation of AsH_3 increases strongly with increasing current density; with 1 amp./dm.^{2} AsH_3 could be detected after 43 hr., but this time decreased with 2 amp./dm.^{2} to 12 hr. and with 5 amp./dm.^{2} to 1 hr. 7 references. Ha (7a)

The Influence of Peroxide of Hydrogen on Electrolytic Chromiumplating (Ueber den Einfluss von Wasserstoffsuperoxyd auf die elektrolytische Verchromung) F. MÜLLER & R. PIETZSCH. *Korrosion u. Metallschutz,* Vol. 15, Apr. 1939, pp. 122-126. Research. Experiments were made to improve the range of bright Cr-plating, depth of throwing power and current efficiency by addition of H_2O_2. The range of bright-plating was not particularly improved, but throwing power and current yield were favorably changed. The amount of H_2O_2, the temperature of the bath and current density have no great effect. Tests were generally made with 5 cc. H_2O_2 of 38.5%. The most favorable ratio of Cr_2O_3 to CrO_3 in the bath was 6%, which should not be exceeded. To produce 1 g. Cr_2O_3, about 1.6 g. H_2O_2 has to be added; the reaction taking place by addition of H_2O_2 is probably $2\ CrO_3 + 4\ H_2O_2 \rightarrow Cr_2O_3 + 4\ H_2O + 7\ O$. A curve is given showing the range of bright-plating for different cathodic current densities as a function of temperature; for more than about 15 amp./dm.^{2} this range extends roughly from 40° to 55° C. 13 references. Ha (7a)

The Electro-plating of Aluminium and Light Alloys. *Aluminium & Non-Ferrous Rev.,* Vol. 4, Feb. 1939, pp. 97-98. Descriptive. Many treatments are in use to permit electroplating on Al alloys. The disadvantages of most of these treatments are that they are applicable only to a limited number of alloys, they etch the base metal to a great extent (preventing perfect finish), and they require preliminary Ni plating. A process giving better results is as follows: The natural oxide film on the Al is increased by anodic oxidation; the second step consists in depositing a metal that facilitates adhesion. One simplified process uses a salt ("Aluvolt C," the composition of which is not revealed) dissolved in water. A large variety of alloys can be plated after

this treatment. Cu, brass, Cd, Ag can be plated direct; some alloys require thin Cu-coating. Before Ni is plated on Al alloy, a previous Cu plating in a cyanide solution for 10-15 min. is sufficient. Ni-plated Al-alloys can readily be Cr-plated. No special equipment is required. RPS (7a)

Recovery of Gold and Silver from Plating Solutions. FRANK K. SAVAGE. *Metal Ind., N. Y.,* Vol. 37, Apr. 1939, p. 160. Practical. Ag in rinse water is recovered by deposition on scrap Zn (borings and turnings) in a recovery tank 25 ft. long constructed with glass baffles. Zn chips should be free from grease, oil or other contamination. Au is plated out of solution in a cell equipped with several brass cathodes and C anodes, by using 6-volt bus bar potential. The cathodes are equipped with cloth bags to hold any Au that drops off after deposition. Periodically, the cathodes are removed, the bags burned, the brass dissolved in HNO_3 and the Au purified by solution in aqua regia and precipitation with ammonia. CBJ (7a)

7b. Non-Electrolytic Methods

Tin-plate Manufacture in Germany. *Metallurgist* (Suppl. *Engineer*) Dec. 1938, pp. 187-189. Extended abstract of the report to the Materials Committee of the Verein deutscher Eisenhüttenleute by Fritz Peter in *Stahl u. Eisen,* giving the practice in tin-plate manufacture in Germany. 25 g./m.^{2} (0.08 ozs./ft.^{2}) Sn is considered a sufficient coating weight, but in practice generally 35-50 (.11-.16 ozs./ft.^{2}) is found. Cold reduction of the sheet of from 1 to 2½% did not appear to improve the tinning properties as previously reported. Normalizing is carried out in many tin-plate works and then followed by pickling, polishing (cold rolled) and then softening by a temper anneal.. The final white pickling before tinning should be as light as possible and preferably carried out with an acid concentration of from 3 to 7%. The temperature should not be higher than 50° C. with a HCl pickle, and not above 85° C. if H_2SO_4 is used. Tinning machines are usually of one of two types: The "Abercarn," which is a double sweep pot, and the "Aetna," which is single sweep. Zinc chloride is employed almost exclusively as a flux, although certain additions may be made, *e.g.* stannous chloride, aluminum chloride, potassium fluoride, sal ammoniac, etc. In the author's experience the percentage of ammonium chloride should be kept below 8% since a greater concentration than this causes increased porosity of the tin coating. On the average, 20.2-22.6 g./m.^{2} of zinc chloride are utilized. The tin bath should be as pure as possible. Pb will be present from 0.03 to 0.05%, sometimes up to 0.1%. Molten Sn will dissolve up to 0.3% Fe at 300° C. Attack on the metal of the Sn pot is particularly severe at the flux-air and oil-air interfaces. Cu, introduced from Cu-bearing steel sheets or from bronze pickling equipment, up to 0.2%, will cause spangling of the Sn coating, but it is not otherwise deleterious. Temperature of the Sn is maintained at about 300° C. at the flux end and 240° C. at the exit end. Palm oil has an acid reaction and, after some time, forms Sn soaps. Efforts to find a suitable substitute for palm oil have so far been unsuccessful, either for technical or economic reasons. The utilization of used flux which may contain up to 10% Sn and is frequently contaminated with palm oil, is extremely difficult. Free Sn is separated by washing away the flux. The hard tin, or "scruff" ($FeSn_2$), being heavier than the unalloyed metal, collects at the bottom of the tin pot and is removed every week. It is usually considerably contaminated with palm oil, from which it is freed by saponification of the latter with caustic soda. The separated residue is then melted to yield a product containing 50-60% Sn, which is sent to refineries, along with the other residues mentioned above, for recovery of Sn. Tin-plate today is usually cleaned with bran, the earlier mixtures of sawdust and gypsum having been found somewhat less efficient. If wet cleaning methods are used, the palm oil is not recoverable, and it is also considered that the appearance of the tinplates is not quite so brilliant after wet cleaning. The costs of cleaning form at present only a small percentage of the total cost of production, and attempts to economize would not, therefore, result in very great advantages. It is considered, however, that economies would result from standardization of the size of sheets and by packing the sheets in larger units, *e.g.* increasing the weight of a basis box by 50%. VVK (7b)

Metal Sprayed Bearings. HARRY SHAW. *Metal Ind. London,* Vol. 54, Apr. 14, 1939, pp. 415-418. Original research. The tests that form the basis of the work relate to sprayed bearing metal rather than to sprayed steel on shafts. They were carried out at low and high speeds (1000 and 3000 ft./min.) with loads up to 8000 lbs./in.^{2} A large variety of alloys and different methods of applying were studied. The general tendency is for the coefficient of friction to drop with increase in load to a minimum value and then rise again. The use of a metal in the sprayed form instead of in the cast form results in lower friction and in higher seizure loads. Sprayed babbitt has a coefficient of friction (at a speed of 1000 ft./min.) which is 25% lower than that of the cast metal and the seizure load increases from 5,760 to 7,040 lbs./in.^{2} Before the seizure load is reached in a cast babbitt, a point of instability of friction is obtained; this condition never occurs with sprayed metal. The static friction of the sprayed babbitt is about a third of that of the cast. Sprayed Pb-bronze has better anti-frictional properties when new than the cast alloy at all speeds. The seizure load of the sprayed metal is about 20% higher than that of the cast metal. In spite of their comparative high friction as compared to babbitt, the Pb-bronzes find extensive use because of their high impact resistance. The seizure load is lower than that of babbitt. Cd-Ni, Cd-Ni-Ag and Cd-Ag-Cu have higher coefficients of friction than the Sn-base bearing metals. Cd-Ag has a higher seizure load and lower friction than Pb-bronze. The new pitted back Sn-coated bearing has a coefficient of friction that is but a fraction of Pb-bronze or Cd-Ag-Cu. No seizure occurred at loads below 8000 lbs./in.^{2} Colloidal graphite in the oil reduces the coefficient of friction and raises the seizure loads. The action of the graphite on the friction is most pronounced at the higher loading conditions. Sprayed Al for bearings is of interest. Certain alloys, such as Al with 20% Pb, form bearings similar in performance to Pb-bronze, but are almost uncastable. They can be produced with ease by metal spraying using 2 wires of the required metal. RWB (7b)

Metal Spraying by the Powder Pistol. *Light Metals,* Vol. 2, May 1939, pp. 187-189. Descriptive. Metal spraying by means of the powder pistol allows a greater variety of metals and alloys to be sprayed than any other form of sprayer. Spraying devices that use wire are limited to metals that may be drawn into wire, while the molten metal guns are limited to comparatively low melting-point metals and alloys that form homogeneous melts. By means of the powder pistol a sprayed coating of such refractory metals as cast iron and manganese steel can be produced which is impossible with other types of pistols. The Schori metal powder pistol is particularly well-designed and is adaptable to any composition of metal powder. Early designs of powdered metal sprayer were subject to clogging, as compressed air was used to force the powder along the pipe line; whereas the Schori pistol sucks air along the pipe line by the partial vacuum created in the pistol. The powder is thus suspended in air at a reduced pressure, and packing is impossible. [The construction of the pistol is illustrated in considerable detail.] The use of a clean, freshly abraded surface for spraying is, of course, essential—as in any other method of metal spraying. The applications of metal spraying are surprisingly diverse. Zn and Al are the 2 metals used most widely, chiefly for corrosion protection. Tanks, drums, welded containers, exhaust manifolds, food containers, and other equipment too numerous to mention are commonly protected by this method. A sprayed metal surface is ideal for holding a paint coating; and the non-skid, rather rough surface produced by metal spraying has been found excellent for walkways in aircraft and motorboats. Al sprayed on Fe and steel is used to confer non-scaling properties at elevated temperatures to articles thus protected. In many cases, this method may be employed where ordinary cementation methods are inapplicable, owing to the size of the piece to be protected, or to the necessity of doing the job on the spot. AUS (7b)

The Effect of the Baking Temperature and Thickness of a Bakelite Lacquer on its Chemical Resistance and its Adhesion to Aluminum (Der Einfluss der einbrenn Temperatur und Schichtdicke eines Bakelitlackes auf seine chemische Beständigkeit und seine Haftfestigkeit auf Aluminium) H. NEUNZIG. *Korrosion u. Metallschutz,* Vol. 15, Jan./Feb. 1939, pp. 40-43. Practical. While the chemical resistance of phenolformaldehyde lacquers increases with increase in baking temperature, the adhesion of the oxide films on metals decreases very rapidly above a certain temperature. If, therefore, a Bakelite lacquer is to be put on a treated Al surface, the temperature should be such that the lacquer film still possesses sufficient elasticity. Comparative tests were made, the results of which are compiled in a table showing corrosive agents, protective value and behavior of differently produced protective Bakelite layers on variously treated Al surfaces. A generally satisfactory temperature seems to be 180°-190° C., but the kind of corrosive agent and shape of the piece exert a decisive influence. Ha (7b)

A Study of the Surface Improvement of Metals by Diffusion (Untersuchungen über die Oberflächenveredelung von Metallen durch Diffusion) W. SEITH & H. JAG. *Z. Metallkunde,* Vol. 30, Oct. 1938, pp. 366-372. Experimental, plus extensive review. It was demonstrated that an Al surface could be enriched in Mg, Cu or Mn; surface of Mg with Al, Sn, Bi or Cu; and surface of Cu with Si, Be, Sn or Sb. If the source of the diffusing element is the pure metal, the surface of the product will be brittle and rounded at the edges owing to the formation of intermediate phases. However, if the diffusing element is supplied from the phase with which the metal of the surface to be treated can exist in equilibrium, the product is satisfactory. GD (7b)

8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID

AND G. R. HARRISON,

SECTION EDITORS

The "Pack" Method for Compressive Tests of Thin Specimens of Materials Used in Thin-Wall Structures. C. S. AITCHISON & L. B. TUCKERMAN. *Nat. Advisory Comm. Aeronaut.*, Report, No. 649, 1939, 11 pp. Original research. The strength of modern lightweight thin-wall structures is generally limited by the strength of the compression members. An adequate design of these members requires a knowledge of the compressive stress-strain graph of the thin-wall material, as tensile testing alone may result in unsafe structures. The "pack" method was developed at the National Bureau of Standards with the support of the National Advisory Committee for Aeronautics to make possible a determination of compressive stress-strain graphs for such material. In the "pack" test an odd number of specimens are assembled into a relatively stable pack, like a "pack of cards." Additional lateral stability is obtained from lateral supports between the external sheet faces of the pack and outside reactions. Studies have been made of the reproducibility of the test results by testing packs taken from sheets of aluminum alloy 17ST and steel. The largest spread in yield strength was about 2 per cent. Tests were also made to determine whether the results from packs were like those obtained from compact solid specimens. The results indicated that the method of transverse support had no appreciable effect on the yield strength. The largest difference between a pack and a solid specimen was 1.60 per cent. Experience gathered in developing the test emphasized the fact that, while the method seemed to furnish results within the same order of accuracy as was usually obtained from other mechanical tests, such as the tensile test, it must be simplified before it can be used economically for inspection testing. The test seems adequate, however, for many problems in structural research. (T-8)

Electron Diffraction Examination of Metals. M. L. FULLER (N. J. Zinc Co.) *Metals and Alloys,* Vol. 10, Mar. 1939, pp. 85-89; Apr. 1939, pp. 122-125. Descriptive. Details are given of the construction and operation of an electron diffraction camera. The camera described incorporates certain features of those of L. H. Germer and Raymond Morgan. The electron source is of the hot filament type and the velocity or effective wave length of the electrons is controlled by supplying the cathode ray tube with uniform-voltage d. c. at about 40 kv. The filament assembly permits easy replacement and convenient adjustment of cathode ray direction. Remarkable positional flexibility is also incorporated in the specimen holder and carrier system. The entire unit is very compact, occupying a floor space of 3½ x 5½ ft., exclusive of the transformer. Examples are given of application of the equipment to investigation of various surface conditions on Zn, and some typical photograms are included. FPP (T-8)

A Multiple Hardness Tester for the Investigation of the Dependence of Hardness Upon Time (Ein Vielfachhärteprüfer Zur Untersuchung der Zeitabhängigkeit der Härte) H. KOSTRON. *Metallwirtschaft.* Vol. 18, Feb. 3, 1939, pp. 106-111. Experimental. An automatic hardness tester that takes hardness readings with time is described. The machine can be used to study age hardening, recovery or recrystallization and grain growth at room or elevated temperatures. Brinell readings can be obtained simultaneously on 18 specimens. The time intervals between readings can be arranged to follow a geometric series or a simple arithmetic progression. Flat plates 80 x 80 mm. are used as specimens, and as many as 441 readings can safely be taken on a plate. The specimens necessarily have to be smooth and flat. This latter feature requires a careful quenching technique to prevent warping. After the test is over, the plates are taken out and hardness readings taken by running the plate on a stage under the Brinell microscope. A 1 mm. diameter ball with a 10 kg. load is applied for 30 sec. in the apparatus, which is described by the liberal use of photographs. Hardness curves for several experimental runs are presented. GA (T-8)

Testing the Brinell Hardness of Thin-walled White Metal Bearings (Die Prüfung der Brinellhärte von dünnwandigen Lagerausgüssen aus Weissmetall) R. KÜHNEL & A. PUSCH. *Metallwirtschaft,* Vol. 18, Jan. 20, 1939, pp. 63-65. Original research. Brinell hardness tests with varying loads and ball diameters were made upon white metal plates cast onto bronze and steel plates and machined to thicknesses of 0.5, 1.0, 1.5 and 2 mm. with the purpose of determining the influence of the backing material on hardness readings. White metal bearings (79.2% Sn, 11.6% Sb, 6.7% Cu and 2.5% Pb) cast on bronze backings were machined to the thicknesses listed above. For the 0.5 mm. thick casting, even with the smallest Brinell ball diameter and load (2.5 mm. ball and 15.6 kg. load), no absolute conformity with the thicker castings was obtained. For the castings 1-2 mm. in thickness the maximum load used should be 125 kg. with a 5 mm. ball. A 10 mm. ball with a 250 or 500 kg. load is inaccurate for testing bearings of the above thicknesses. The Brinell machine for testing these thin white metal bearings should have a maximum scale of not over 500 kg.; readings on the 3000 kg. capacity machine will be affected by friction at low loads as low as 125 kgs. GA (T-8)

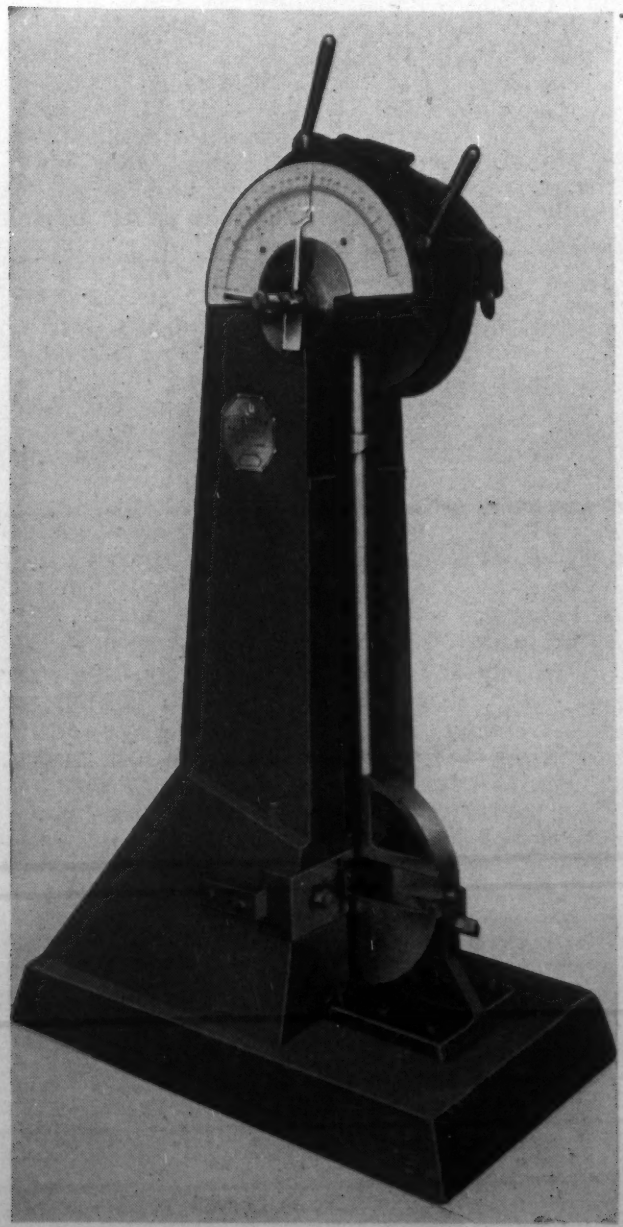
Materials Testing of Automobile Parts that Survived Long-time Operation (Werkstoffuntersuchungen an langjährig bewährten Kraftfahrzeugteilen) K. DAEVES & E. SCHERER. *Maschinenbau Betrieb,* Vol. 18, Feb. 1939, pp. 77-80. Original research. Old automobile parts that had been satisfactory in service were subjected to routine tests. The fact that certain parts stood up in service but did not come up to modern specifications would prove that the specifications are too rigid, which means waste of material. 65 highly stressed machine parts were tested; their strength had been computed on the same basis as in use today. Only small deviations from the modern specifications as to chemical and mechanical properties are found. Some piston pins show granular fracture which is popularly considered an indication of inferiority. Overheated structure in the case and flaws as shown by magnetic tests exist in many such parts. Since none of the parts examined failed during operation, fracture, case structure and flaws due to slag inclusions or faulty forging are not absolute grounds for rejecting such parts. [No fatigue tests were made.—R. P. S.] RPS (T-8)

The "Final Hardness" of Döhmer, a Useful Material Constant (Die Endhärte nach Döhmer, eine wertvolle Werkstoffkennzahl) P. W. DÖHMER. *Z. Metallkunde,* Vol. 31, Jan. 1939, pp. 15-16. Theoretical. Curves are drawn to illustrate that the ordinary Brinell hardness number and Meyer hardness number depend upon the pressure used in testing. The expression $P_{max} = a[nD\sqrt{1-2/n}/(n-1)]^n$ is derived from relating Brinell hardness to pressure. P_{max} is the pressure at which the maximum Brinell hardness occurs, D is the diameter of the ball, a and n are the same constants that occur in Meyer's law. From this a "final hardness" can be calculated by the method of Döhmer (*Z. Metallkunde,* Vol. 23, 1930, p. 31). This, in combination with the Brinell number and the Meyer constants, gives information on the heat treatment, cold working and degree of stress in the metal. GD (T-8)

Some Pros and Cons of Radiography. G. C. MCCORMICK (Gen. Alloys Co.) *Bull. Am. Soc. Testing Materials,* Dec. 1938, pp. 25-28. Discussion. It is emphasized that castings showing defects in X-ray examination may perform well, and other castings free from defects as detectable by the X-ray may not have the degree of soundness that the consumer expects. In the foundry industry, the X-ray's greatest utility will come in its employment as a development tool and as a check inspection device on castings involving life and vital public service, and as an occasional inspection device on severely stressed parts of mechanism. Examples are given. VVK (T-8)

Hardness and Hardness Measurements. S. R. WILLIAMS (Amherst College) *Instruments*, Vol. 10, Sept. 1937, pp. 237-238; Oct. 1937, pp. 265-266; Nov. 1937, pp. 286-287; Dec. 1937, pp. 311-312, p. 318; Vol. 10, Feb. 1938, pp. 66-67, 76; Mar. 1938, pp. 96-99; Apr. 1938, pp. 115-119; May 1938, pp. 148-153; June 1938, pp. 168-170; July 1938, pp. 185-186; Aug. 1938, pp. 204-206; Sept. 1938, pp. 223-225; Nov. 1938, pp. 283-286; Dec. 1938, pp. 303-306; Vol. 12, Feb. 1939, pp. 71-72. Comprehensive review. For earlier instalments see *Metals and Alloys*, Vol. 9, Feb. 1938, p. MA 110 L/2. Graton's sclerometer and Talmadge's method of scratch hardness testing are discussed. The effect of the surface conditions in scratch hardness tests and the empirical relation between Brinell numbers and scratch widths measured by Hadfield and Main on a large variety of steels are graphically presented. The O'Neill scratch hardness tester, Hankin's sclerometer and Bierbaum's instrument ("microcharacter") are fully described. The application of the latter instrument to Cu, bronze, Zr-nitride and Sn is discussed. Attempts by various experiments to standardize Moh's scale of hardness in terms of some particular hardness measuring device are discussed. Early penetration hardness methods, and particularly the contributions of Reaumur, Toeppl, Haigh, Hertz, Auerbach, Meyer, Hoyt, and Calvert and Johnson are reviewed. The underlying principles of the Brinell machine and 10 types of Brinell hardness testers are illustrated and considered. A conversion diagram for Brinell, Rockwell B and C numbers and tensile strength for rolled and wrought Fe and steel is given. A short description of the Ballentine dynamic indentation tester is included. A very complete description of principle, methods of application, and types (standard, superficial hardness testers) of Rockwell machines is presented, with over 20 illustrations. The (Vickers) diamond hardness tester was developed for reliable testing of metals of a high degree of hardness. If the diamond is not symmetrically set with respect to the direction of the indenting force, the impression will be lopsided. The test pieces must be properly held if consistent results are to be obtained. The later improvements of the original Vickers machine are discussed. Under indentation hardness testers, the Monotron, de Leeuw's method and Ludwik's hardness test are considered. Ludwik's measurements of "internal friction" with temperature for Sn, Bi, Cd, Pb, Zn, Sb, Al and Cu are graphically shown. Discontinuities one might expect in allotropic transformations did not show up in any pronounced fashion. In a section entitled "Elastic Properties as a Measure of Hardness," a differentiation is made between elasticity of volume and form (modulus of rigidity, shearing modulus). After deriving the theoretical foundations, a torsion lathe for measuring the coefficient of rigidity of metal rods is described. The determination of Young's modulus of elasticity or the modulus of stretch including a device for measuring the hardness of springs by the amount of their bending is discussed. Rebound methods of measuring hardness are next considered. The interrelation between tensile strength and Shore scleroscope numbers is demonstrated. It is disclaimed that a higher rebound necessarily indicates a harder material. The inexpensive, easily constructed durometer of Sauveur measures the distance of a free-falling steel ball reflected from a test surface inclined at 45°. A practical application describes the separation of soft steel balls from hard ones by the rebound principle. Walzel's pendulum hardness testing machine used for measuring the "hot hardness" of steels at temperatures up to 900° C. is briefly considered. EF (T-8)

A Survey of Crystal Optics with Emphasis on the Parts Finding Application in Photoelasticity. J. VALASEK (Univ. Minnesota) *J. Applied Phys.*, Vol. 10, Apr. 1939, pp. 209-221. Outline of the basic laws of propagation of light in crystalline media, isotropic and anisotropic. Double refraction, production of polarized light beams and physical methods of measuring phase retardation in superposed waves are discussed. **A Review of the Photoelastic Method of Stress Analysis. I.** R. D. MINDLIN (Columbia Univ.) *Ibid.*, pp. 222-241. Comprehensive review of stress analysis by photoelastic methods. Specification of stress and strain by the usual elasticity theory and relation of these quantities to the accompanying optical effects in the medium are reviewed. Stress-optical relations for two-dimensional photoelasticity are summarized and a description of materials, models, and loading devices is given. Following this is a description of the technique followed in the point by point determination of the principal stress differences and their orientation in the stress plane. Large-field photoelastic patterns and their interpretation are discussed in turn. **Direct Optical Measurement of Individual Principal Stresses.** J. H. A. BRAHTZ & J. E. SOEHRENS (U. S. Bur. Reclamation) *Ibid.*, pp. 242-247. Description of a photoelastic interferometer of the Favre type with which the individual prin-



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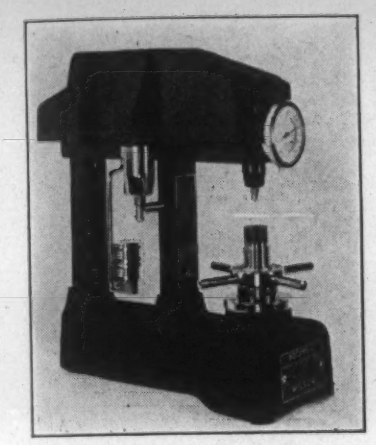

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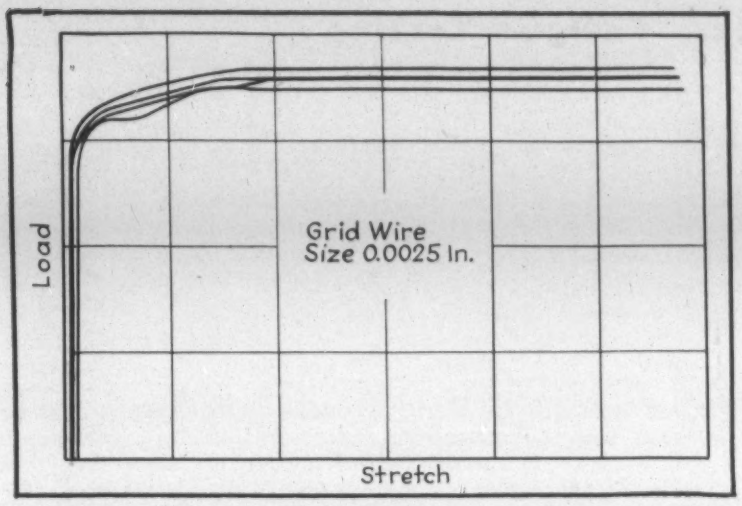
cipal stresses at any point in a loaded photoelastic model may be determined. A hydrostatic loading frame is described in which movement of the model as a whole during loading is avoided. **Isopachic Stress Patterns.** M. M. FROCHT (Carnegie Inst. Tech.) *Ibid.*, pp. 248-257. Description of an optical arrangement with which photoelastic patterns giving the sum rather than the difference of the principal stresses may be obtained. This method is not limited to transparent photoelastic materials *but may be used directly on metals* provided surfaces of sufficient optical flatness may be ground on them. Patterns obtained on a stainless steel ring model loaded diametrically are compared to the pattern obtained with a Bakelite model and good agreement is found between the two methods. The isopachic curves for this case could also be computed by numerical solution of LaPlace's equation and were found to be in good agreement with those observed. **A New Method for Photoelasticity in Three Dimensions.** R. WELLER (Ohio State Univ.) *Ibid.*, p. 266. Short note on a new method utilizing the polarization caused by scattering of light within a cloudy model in place of the unsual analyzer. A plane section through a model is illuminated by a collimated plane-polarized beam and interference fringes appear in this section viewed normally. The theory and technique of this method are still under development. HFK (T-8)

Spectro-analytical Investigation of Steels by Use of the Spark Spectrum (Spektralanalytische Untersuchung von Stählen bei Verwendung des Funkenspektrums) W. HOLZMÜLLER. *Z. anal. Chemie,* Vol. 115, No. 3/4, 1939, pp. 81-102. Research. The investigation was undertaken to collect comprehensive data on the spectrum lines of the most important alloying constituents of steel; the usual interferences are pointed out, particularly those in high alloy steels. A Zeiss quartz spectrograph was used. The alloying constituents of the steels varied in amount, as follows: Al, 0.08-0.5%; C, 0.01-1.3%; Co, 10-15%; Cr, 0.1-30.3%; Mn, 0.06-12.7%; Mo, 0.22-2.34%; Ni, 0.08-19.9%; Si, 0.11-1.98%; V, 0.31-2.38%; W, 0.40-19.6%; Ta, 0.04%; Ti, 0.11-0.57%. The lines observed are tabulated and critically considered. Photos are given of the lines of Al, Co, Cr, Mn, Mo, Nb, Ni, Si, Ti and V steels. The occurrence of the lines depends not only on the amount of alloying element but also on the time of exposure, sensitivity of the photographic plates, gap width and condition of spark excitation. Therefore, it is not advisable to state the concentration at which a given line is just barely evident. Lines subject to considerable interference by Fe were not considered. GN (H-8)



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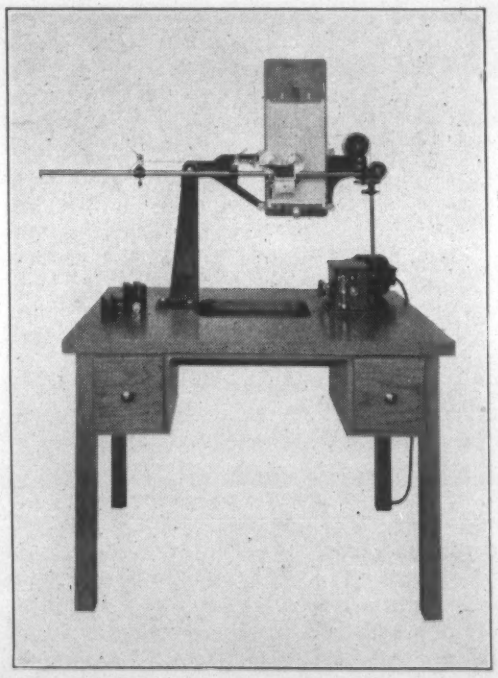

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8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Fatigue Strength of Some Wrought Light Metals Subjected to Various Types of Stressing; Influence of Cold Work (Dauerfestigkeit einiger Leichtmetall-Knetlegierungen bei verschiedenen Arten der Beanspruchung; Einfluss der Kaltverformung) F. BOLLENRATH & K. BUNGARDT. *Metallwirtschaft,* Vol. 18, Jan. 6, 1939, pp. 2-6. Original research. Ten Al alloys belonging to the Al-Cu-Mg, Al-Mg-Si, Al-Mg and Al-Mg-Mn series, as well as a Mg-Mn and Mg-Al alloy, were studied. The physical properties of the original rolled sheet are given; all tests were made on annealed stock. Brief reference is made to the work of others, and alternating bend and torsion fatigue strength are compared. The authors subjected their samples to alternating bending and to tensile stressing (stress varied from zero to a definite value). For comparison purposes, some bend tests were also run from zero stress to a definite value. The stress amplitude in the case of alternating bend stressing is greater than for the case of bend stressing (stress varying from zero to some definite value) because of the higher mean stress in the latter case. The pulsating bend fatigue strength of the Al alloys was found to be 12-34% greater than the pulsating tensile fatigue strength. [This difference may be due, in part at least, to deviation from uniform stress distribution in the specimens subjected to direct tensile stress.—H.F.M.] Comparison of the amplitude of stress range for the alternating bend fatigue strength with that for the pulsating tensile fatigue strength indicated that for Al the difference was 22-45%, and in the case of the Mg-base alloys the differences in amplitude were 45-49%, the greater amplitude being associated with the alternating bend fatigue test. The alternating bend fatigue strength increases with increasing cold work though much less rapidly than the yield strength. Notch sensitivity, determined by comparing the fatigue strengths of notched and unnotched bars, increases with increasing cold work. GA (8a)

Internal Notch Effect and Fatigue Strength (Innere Kerbwirkung und Dauerfestigkeit) H. WIEGAND. *Metallwirtschaft,* Vol. 18, Jan. 27, 1939, pp. 83-85. Discussion. The causes of fatigue failures in structural parts are often ascribed to notch effect without distinguishing between the various types of notch effect. The author classes notch effects as external and internal and in this discussion confines himself to the latter. Internal notches are divided into 3 groups: (1) The structural condition of the material, (2) treatment during working, and (3) the presence of different materials in a structural part. Piping, porosity and slag or sand inclusions can act as stress raisers. Fibering in forgings can also act as notches. The above internal notches all belong to group 1. Improper heat treatment of steels through the formation of martensite leads to a decrease in impact fatigue strength. Surface treatments, such as nitriding and pickling, will lead to the formation of internal notches. The third type of internal notch is that formed by a poor bond at the interface between 2 different metals such as are found in lead-bronze steel backed bearings. The mechanical joining or welding of materials of different moduli of elasticity will cause an internal notch effect. GA (8a)

Effect of Case-hardening on the Endurance Properties in Bending and in Torsion of Smooth and of Drilled Samples (Einfluss der Einsatzhärtung auf die Beige-und Verdrehwechselfestigkeit von glatten und quergebohrten Probestäben) H. WIEGAND & R. SCHEINAST. *Arch. Eisenhüttenw.,* Vol. 12, Mar. 1939, pp. 445-448. Original research. It is well known that the fatigue properties of motor parts may be raised by case-hardening. In these tests the effect of case-hardened and not case-hardened drilled holes on the endurance in bending and in torsion was determined. The samples were 14 mm. thick, of 0.13% C, 2% Cr, 2% Ni, 0.25% Mo steel. With drilled holes that were not case-hardened, the endurance properties were decidedly lower. The results indicated that motor parts having drilled holes or similar notches might well be case-hardened. In the samples tested, the most favorable endurance properties were obtained when the case-hardened layer, about 0.4 mm. deep, was ground down to about 0.2 mm. depth. With case-hardened steel, care in obtaining a finely ground surface is not so important as with steel hardened throughout; the harmful effect of wear, corrosion and fine notches is also much less. SE (8a)

9 Metallography

Structure and Constitution. Metallographic Equipment.

J. S. MARSH, SECTION EDITOR

Special Methods for Polishing Metal Specimens for Metallographic Examination. D. BEREGEKOFF & W. D. FORGENG (Union Carbide Res. Labs.) *Metals Tech.,* Vol. 6, Jan. 1939, T. P. No. 992, 7 pp. Descriptive. Brief descriptions of methods for keeping graphite in cast iron and inclusions in steel during polishing, and methods for polishing very soft and very hard metals are given. In general, specimens are flattened on a file or sharp cutting sand belt. Abrasive papers Nos. 2, 1, 0, 00 and 000 are used consecutively, and the final wet polishing is done on a cloth-covered metal disk, woolen broadcloth or optical glass polishing felt being used on the last lap. For retaining graphite or inclusions, a hard cloth, such as airplane fabric or an unbleached muslin, is employed. Best surfaces are obtained when polishing time on the cloth laps is kept at a minimum. After the No. 000 paper has been applied, the specimen is finished on worn No. 000 paper coated with graphite from an electrode piece. To retain graphite in cast iron, it is necessary to polish for a much longer time, particularly on the No. 2 paper. To retain inclusions in steel specimens, polishing on the graphite-coated No. 000 paper is protracted to expose the inclusions; airplane fabric is used as the finishing cloth with fine Al_2O_3 or "light" MgO. Scratches may then be removed without dislodging inclusions (except alumina inclusions) by a final polishing on velvet with the finest relevigated alumina. Hard metals, such as stellite tools and W carbide, are polished on special diamond-impregnated polishing disks. JLG+FPP (9)

9a. Ferrous

J. S. MARSH, SECTION EDITOR

The Mechanism of the Eutectic Transformation of White Cast Iron. K. BUNIN & S. RAPOPORT. *Metallurg,* Vol. 13, Nov. 1938, pp. 29-34. In Russian. Research. The cast iron studied contained 3.6% C, 0.36% Si and 1.7% Mn. The samples were kept for 5 min. at 1350° and then cooled at the rates of 20, 30 and 168°/min. The cooling speed was the average in the interval from the start of the crystallization to the eutectic temperature. At certain moments, the cooling was interrupted by quenching in water. As a result of the eutectic transformation during gradual cooling, a coarse austenite-cementite structure that had no eutectic character was formed by the direct crystallization of the cementite in the course of the eutectic decomposition of the liquid. But during rapid cooling, the character of the structure obtained during eutectic solidification changes radically, becoming ledeburite. Analysis of the ledeburite structure shows that it crystallizes in a form very nearly spheroidal. The eutectic transformations in mottled iron were also studied. The gray component appears before the white, and this lends support to the theory that the graphite crystallizes directly from the liquid. BZK (9a)

Niobium-iron and Niobium-iron-carbon Alloys. *Metallurgist* (Suppl. *Engineer*) Dec. 1938, pp. 185-187. Extended abstract of paper by H. Eggers & W. Peter *(Metals and Alloys,* Vol. 10, Apr. 1939, p. MA 226 L/1) on the constitutional diagrams of the Cb-Fe and Cb-Fe-C alloys. VVK (9a)

Scale for Deep Etching Tests on High Carbon Steel Bars (En skala för djupetsningsprov på stångstål vid högre C-halter) R. ARPI, H. KJERRMAN & G. THALEN. *Jernkontorets Ann.*, Vol. 122, No. 11, 1938, pp. 581-591. Descriptive. A scale has been designed consisting of 5 macrographs showing different degrees of pitting and arbitrarily graduated from 1 to 5. The sections to be tested are cut from steel bars with a coldsaw. Machining is preferable though not necessary. An etching solution of 1:1 HCl is used at 70° C. The specimens are preheated to the same temperature before immersion and given a 45-min. etch. Because acid concentrations should not decrease more than 10%, the recommended quantities are 200 cc./100 cm.^{2} of specimen surface. After etching, the samples are cleaned and compared with the scale. Reprints of the scale with an English translation of methods of preparation are available through *Jernkontorets Annaler*. HCD (9a)

Study of Conditions Necessary for Uniform Results in Deep Etch Testing (Orienterande undersokning av betingelserna för erhållande av konstanta resultat vid djupetsning) BO WESSLEN. *Jernkontorets Ann.*, Vol. 122, No. 11, 1938, pp. 592-609. Original research. The position in the ingot from which the test specimen is taken considerably affects the result, but the specimen surface treatment is unimportant. The presence of $FeCl_3$ in the etch solution increases the amount of etching, whereas $PbCl_2$ and $FeCl_2$ decrease it. All 3 slightly improve the appearance of the etch. Arsenic in the etching solution gives a very irregular etch. The concentration of HCl is very important and should not change by more than one-tenth during the etching; temperature should be maintained at 70° C. An etching time of 45 min. is adequate. HCD (9a)

Applied Metallography in the Steel Working Industries (Angewandte Metallographie in der stahlverarbeitenden Industrie) H. DIERGARTEN. *Metallwirtschaft*, Vol. 17, Dec. 6, 1938, pp. 1328-1338. Illustrated discussion of the systematic application of metallography to the economic and technical problems of the steel-working industries. Rating charts for steel microstructures make metallographic examination more useful, especially on a comparative basis. A series of such charts for oxide and sulphide inclusions of various shapes are reproduced that aid in classifying steel from one or many sources. Rating charts can be applied to carbide segregation in structural or tool steels, to the control of heat treatment and grain size, and to the estimation of surface quality or roughness. The author has found a Cr plate satisfactory for supporting the surface edge to be examined. Automatic polishing of a large number of specimens is described, using specimens set in gypsum so as to project beyond the surface of the gypsum. GA (9a)

The System Iron-chromium-phosphorus (Das System Eisen-Chrom-Phosphor) R. VOGEL & G. W. KASTEN. *Arch. Eisenhüttenw.*, Vol. 12, Feb. 1939, pp. 387-391. Original research. Before the ternary system Fe-Cr-P could be determined, the binary system Cr-P had to be studied. The existence of the previously unknown compounds Cr_2P and Cr_3P was established. The system Fe-Cr-P up to 28% P was determined by microscopic and thermal methods, and is shown by 8 sections through the ternary diagram. Between the compounds Fe_2P and Cr_2P and Fe_3P and Cr_3P there form continuous solid solutions. Three primary phases may be distinguished: Fe-Cr-P, Fe_3P-Cr_3P and Fe_2P-Cr_2P. The Fe-Cr-P solid solution forms a eutectic with the Fe_3P-Cr_3P solid solution. The Fe_2P-Cr_2P solid solution forms a peritectic with the Fe_3P-Cr_3P solid solution. The Fe_2P-Cr_2P solid solution also forms a eutectic with an unknown P-rich phase. The closed γ loop of the Fe-P system remains closed with the addition of Cr, but the γ field is extended to 1.8% P at 1140° C. SE (9a)

Effect of Manganese on the Position of the Lines on Maurer's Diagram. L. S. DLUGACH, V. K. DEGTYAREVA & K. F. STARODUBOV. *Metallurg*, Vol. 13, Nov. 1938, pp. 23-28. In Russian. The effect of Mn on the structure of cast iron containing 3.23-3.76% C was investigated. The amounts of Mn and Si were varied from 0.72 to 2.91%, and from 0.94 to 3.22%, respectively, by adding powdered Fe-Mn and Fe-Si to the bottom of the ladle and mixing the contents thoroughly. The Maurer diagram for cast iron with 1% Mn was rechecked and a new diagram for 2% Mn was made. In this new diagram, the boundary between the pearlite and ferrite-pearlite regions is shifted to the right and passes through the ordinate of 2.75% Si. The boundary between the cementite-pearlite and the pearlite regions goes through the ordinates of 1.2 and 1.5% Si. The absolute hardness is higher for the 2% Mn samples than for 1% Mn samples having the same structure. BZK (9a)

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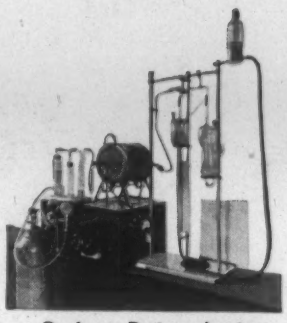

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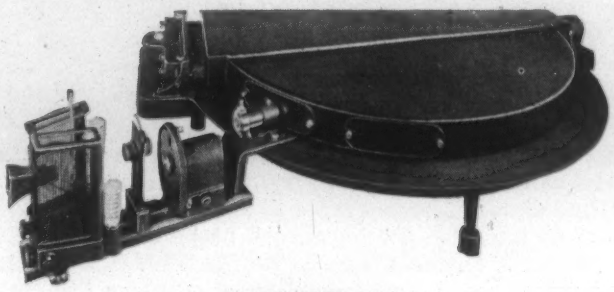

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9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

Electric Conduction and Diffusion in Semi-metallic Alloys. III. $Cu_{2-x}Te$ (Elektrizitätsleitung und Diffusion in halbmetallischen Legierungen. III. $Cu_{2-x}Te$) H. REINHOLD & HELMUT BRÄUNINGER. *Z. physik Chem.*, Abt. B, Vol. 41, Dec. 1938, pp. 397-426. Original research. Continuing the series of investigations on semi-metallic compounds of non-stoichiometric composition (See *Metals and Alloys*, Vol. 9, Nov. 1938, p. MA 672 R/1), the authors determined the electric conductivity, thermal e.m.f., diffusion constant and electrolytic transference number as depending on temperature, preliminary heat treatment, and composition of Cu-Te alloys with about 50-55 wt.% Te, represented in the authors' notation by the formulas Cu_2Te and $Cu_{1.65}Te$, respectively. The electric conductivity varies reversibly with the temperature between —180° C. and any temperature above 360° C. to which the specimen has previously been heated, but its value for any one composition and any one temperature increases with every increase of the highest temperature value previously attained on heating. About 250° C. is the temperature of beginning recrystallization of the investigated alloys. The thermal e.m.f. of each alloy passes through a minimum at a test temperature that is the lower the higher the temperature of preliminary annealing, thus being a sensitive indicator of the physical condition of the alloy. The diffusion constant increases with the temperature, changing only slightly within the temperature intervals of the individual polymorphic modifications of $Cu_{2-x}Te$, but rising discontinuously on phase transformation. The results of the electrical conductivity, thermal e.m.f. and diffusion measurements indicate that the conduction of electrons in the investigated alloys is predominantly of the "electron defect" type, characteristic of semi-conductors. ORS (9b)

The Ag_3Ga-AgZn Solid Solution Series in the Ternary System Silver-gallium-zinc (Ueber die Mischkristallreihe Ag_3Ga-AgZn in ternären System Silber-Gallium-Zink) KURT MOELLER, *Z. Metallkunde*, Vol. 31, Jan. 1939, pp. 19-20. Experimental. The literature indicates that Ag_3Ga and AgZn are isomorphous. X-ray and microscopic analysis show that in the ternary Ag-Ga-Zn system these low temperature phases form a continuous series of solid solutions. At high temperatures, a body-centered cubic modification of Ag_3Ga is formed. GD (9b)

Investigation of the Al-Zn System (Untersuchungen im System Al-Zn) W. GUERTLER, H. KRAUSE & F. VOLTZ. *Metallwirtschaft,* Vol. 18, Feb. 3, 1939, pp. 97-100. Research. The solidus line in the Al-Zn system for alloys containing 20-50% Al was determined microscopically. Seven alloys in this range, made up of pure Al (99.9%) and pure Zn (Kahlbaum), after homogenization, were heated at temperatures from 380 to 470° C. for ½ hr. at 10° intervals and after quenching in ice water examined microscopically for fusion. The following points on the solidus line were determined: 20% Al, 385° C.; 25% Al, 400° C.; 30% Al, 420° C.; 35% Al, 440° C.; 40% Al, 450° C.; 45% Al, 460° C.; and 50% Al, 470° C. The solidus curve shows a sharp change in direction between 30 and 40% Al. In the region from 20 to 30% Al, there is a marked change in the solubility of Zn in Al in a very short temperature range, which accounts for the appearance of large α crystals (Zn solid solution) after quenching from the liquid state, whereas alloys of these compositions normally consist mostly of α and β (Al solid solution) resulting from eutectoid decomposition. [The solidus curve is similar in type to that determined by Gayler and Southerland (*Metals and Alloys,* Vol. 10, Mar. 1939, p. MA 176 L/6) though at the lower percentages of Al (20-30%) it is from 20° to 30° C. lower than that of the British workers.—G.A.] GA (9b)

Ternary Alloys Containing Magnesium and Cadmium, and the Binary Magnesium-cadmium Diagram. II. (Ueber Magnesium-Kadmium-haltige ternäre Legierungen und das Zustandsbild der binären Magnesium-Kadmium-Legierungen. II) E. JAENCKE, L. NEUNDEUBEL & K. RUMPF. *Z. Metallkunde,* Vol. 30, Dec. 1938, pp. 424-429. Research. On the basis of the literature it is shown that the Cd-Mg diagram must be revised to include the following specifications: The α solid solution extends to about 18 atomic % Cd. At 530° C., the peritectic reaction α + melt ⇌ β occurs. The β solid solution extends from 19% to 38% Cd. At 442° C., the peritectic reaction β + melt ⇌ γ occurs and the γ solid solution extends from 40 to 66% Cd. At 357° C. the peritectic reaction γ + melt ⇌ δ occurs and the δ solid solution extends from 71 to 78% Cd. At 331° C., the peritectic reaction δ + melt ⇌ ε occurs and the ε solid solution extends from 80 to 100% Cd. The β phase undergoes a polymorphic transformation to β′ in the temperature range from 180° to 130° C. The δ phase transforms to δ′ in the range from 120° to 90° C. The γ phase forms a superlattice at 250° C. Such a diagram is in agreement with the known diagrams for the ternary alloys of Cd and Mg with Zn, Al, Ag, W and Tl. On this basis, the Cd-Mg-Zn and Cd-Mg-Al diagrams were redetermined more accurately. For Part I see *Metals and Alloys,* Vol. 10, May 1939, p. MA 299 R 4. GD (9b)

Factors Affecting the Limit of Solubility of Elements in Copper and Silver. E. A. OWEN & E. W. ROBERTS. *Phil. Mag.,* Vol. 27, Mar. 1939, pp. 294-327. Research. The earlier work of Hume-Rothery and Westgren, which established certain facts with respect to the solubility of elements in binary alloys, (particularly, a relation in whole numbers of the electron concentration) was extended to determine the effect of valency and of temperature on the lattice parameters of Ag and Cu alloys. In the Ag series, the lattice relations adduced per atom of Cd, In, Sn and Sb are approximately in the ratio 2:3:4:6 (thus not quite confirming Hume-Rothery); the deviation from the whole numbers ratio is greatest in Ag-Sn alloys, about 6%. In the Cu series, Zn, Ga, Ge and As have lattice relations in the ratio 3:4:5:7, with the greatest deviation from it for Cu-Ga alloys with 4%. Temperature has practically no effect on the parameter factors. The temperatures at which maximum solubility occurs are those of the peritectic horizontals or the eutectic transformations. In general, the results show that as the electron concentration diminishes the percentage distortion also diminishes, but at a greater rate. Ha (9b)

Transformation of the β Phase and Its Solubility in α Phase in Ni-Si Alloys. M. OKAMOTO. *Nippon Kinzoku Gakkai-Si,* Vol. 2, Nov. 1938, pp. 544-551. In Japanese. Original research. The solubility of Si in Ni decreases from the maximum value of 9.3% Si at 1120° C. to 6.5% at 900° C., and finally to 5.4% Si at room temperature. The change of β at 1120° C. was concluded to be $\beta_3 \rightleftarrows \beta_2$, revising the previous diagram by the author; β_2 further undergoes a change $\beta_2 \rightleftarrows \beta_1$ at 1040° C., as ascertained by dilatometric measurement. **The β_1 Phase of the Ni-Si System.** K. KUSUMOTO. *Ibid.,* Dec. 1938, pp. 617-619. In Japanese. Original research. An X-ray study of the crystal structure of β_1 phase showed that it is a face-centered cubic solid solution, of the chemical formula Ni_3Si and has a superlattice, Ni atoms occupying centers of cube faces and Si atoms cube corners. NS (9b)

An X-ray Analysis of Alloys of the Nickel-silicon System. ATOMI OSAWA & MASAZO OKAMOTO. *Sci. Repts. Tohoku Imp. Univ.,* Vol. 27, Jan. 1939, pp. 316-345. In English. Original research. Diagram and crystal data reproduced also in *Metal Progress,* Vol. 35, May 1939, p. 488. See *Metals and Alloys,* Vol. 10, Jan. 1939, p. MA 50R/5. AUS (9b)

The Crystal Structure of Cu_3As and Cu_3P. BÖRJE STEENBERG. *Arkiv. Kemi, Mineralogi, Geologi,* Vol. 12a, June 27, 1938, 18 pp. In English. Original research. The crystal structure and the stability range of 3 different phases with the formula Cu_3As were investigated. The cell dimensions of artificial "domeykite" are a = 7.088 A.U., c = 7.232 A.U., c/a = 1.020. Space group is D^4_{3d}. The low atomic radius of As (1.12 A.U.) is attributed to a polarization of the atom. The mineral domeykite is cubic with a = 9.592 A.U., belongs to the space group T^4_4, and is stable only below 225° C. Attempts to produce domeykite artficially failed. Agodomite has the formula Cu_3As and not $Cu_{4-6}As$, belongs to the Cu-As diagram as a low temperature phase of Cu_3As, and is stable below 250° C. A copper phosphide, Cu_3P, is found to be isomorphous with "artificial domeykite." Its elementary dimensions are a = 7.070 A.U., c = 7.135 A.U., c/a = 1.008. The iron phosphide Fe_3P crystallizes in the space group S^2_4, and its structure is analogous to the domeykite cell. EF (9b)

The Mg-Mg_3Al_2-Mg_3Bi_2 Region of the Ternary System Magnesium-aluminum-bismuth (Der Teilbereich Mg-Mg_3Al_2-Mg_3Bi_2 des Dreistoffsystems Magnesium-Aluminium-Wismut) E. SCHEIL & B. GLAUNER. *Z. Metallkunde,* Vol. 31, Mar. 1939, pp. 76-79. Experimental. Thermal and microscopic analysis were used to determine the equilibrium diagram for Mg-rich alloys with Al and Bi. The 2-liquid region of the Al-Bi system extends into alloys containing 42% Mg, 30% Bi, 28% Al. The ternary eutectic falls at 435° C., 88% Mg, 10% Al, 2% Bi. The polymorphous transformation in the Mg_3Bi_2 phase has no other effect on the system. The Mg_3Al_2-Mg_3Bi_2 section is a quasibinary eutectic. The Bi content does not influence the hardness of the as-cast or aged alloys. GD (9b)

The Mg-$MgZn_2$-Mg_5Tl_2 Region of the Ternary Magnesium-zinc-thallium System (Der Teilbereich Mg-$MgZn_2$-Mg_5Tl_2 des Dreistoffsystems Magnesium-Zink-Thallium) W. KÖSTER & K. KAM. *Z. Metallkunde,* Vol. 31, Mar. 1939, pp. 82-84. Experimental. By thermal and microscopic analysis it was shown that the region contains a ternary eutectic at 22% Mg, 5% Zn, 73% Tl at 360° C., and no phases that do not appear in the corresponding binary systems. Additions of Tl increase the hardness of the cast alloys. Maximum hardness is obtained by aging at about 200° C. Additions of Tl increase the corrosion of Mg alloys in air and tap water, while Zn additions are beneficial. GD (9b)

The Mg-$MgZn$-Mg_3Bi_2 Region of the Ternary Magnesium-zinc-aluminum System (Der Teilbereich Mg-$MgZn$-Mg_3Bi_2 des Dreistoffsystems Magnesium-Zink-Wismut) E. SCHEIL & B. GLAUNER. *Z. Metallkunde,* Vol. 31, Mar. 1939, pp. 80-81. Experimental. Thermal and microscopic analysis were used. The 2-liquid region of the Zn-Bi system extends to alloys containing up to 20% Mg. The 4-phase reactions, melt + $MgZn_2$ ⇌ MgZn + Mg_3Bi_2 at 352° C., and melt ⇌ Mg + MgZn + α Mg_3Bi_2 at 339° C. are very nearly identical with the peritectic and eutectic in the Mg-MgZn system. Additions of Bi have little influence on the hardness. GD (9b)

The Magnesium Corner of the Ternary Magnesium-silver-thallium System (Die Magnesiumecke des Dreistoffsystems Magnesium-Silber-Thallium) W. KÖSTER & K. KAM. *Z. Metallkunde,* Vol. 31, Mar. 1939, p. 84. Experimental. The solid solubility of Ag in Mg is reduced from 10% in the binary system to 4.5% by the addition of 30% Tl. In the same composition range, the Mg-Ag eutectic is lowered from 469° to 432° C. The hardness is increased by both Tl and Ag additions. Corrosion in tap water is increased by Tl, and Ag does not counteract this effect. GD (9b)

Equilibrium Relations in Aluminum-zirconium Alloys of High Purity. WILLIAM L. FINK & L. A. WILLEY (Aluminum Res. Labs.) *Metals Tech.,* Vol. 6, Jan. 1939, T.P. No. 1009, 12 pp. Original research. The Al end of the Al-Zr system was investigated using high-purity alloys containing from 0 to 2% Zr. A peritectic occurs at 660.5° C. (m.p. Al 660.2° C.) between the melt with 0.11% Zr and α (Al-Zr) to form a solid solution containing 0.28% Zr. As the temperature decreases, the solid solubility decreases from 0.28% Zr to approximately 0.05% at 500° C. The Zr-rich constituent α (Al-Zr) consists of very stable tabular tetragonal crystals, which are not discolored or attacked by ordinary etching reagents. Chemical analysis of separated α (Al-Zr) crystals indicated a composition corresponding to Al_3Zr. JLG (9b)

A New Interpretation of the Reported Beta-phase in the Arsenic-antimony System (Eine neue Deutung der angeblichen β-Phase des Systems As-Sb) P. E. WRETBLAD. *Z. anorg. allgem. Chem.,* Vol. 240, Jan. 13, 1939, pp. 139-141. Research. Recent X-ray data of W. Trzebiatowski & E. Bryjak (*Metals and Alloys,* Vol. 10, Mar. 1939, p. MA 174 L/8) are examined and reasons advanced in belief that their reported β-phase consists of a solid solution of As_2O_3 and Sb_2O_3. In reply, W. TRZEBIATOWSKI (*Z. anorg. allgem. Chem.,* pp. 142-144) reviews the methods of preparing alloys and interpretation of the X-ray data, and considers Wretblad's contentions to be without foundation. HFK (9b)

The Solubility of Hydrogen in Aluminum and Magnesium Ueber die Löslichkeit von Wasserstoff in Aluminium und Magnesium) P. RÖNTGEN & H. WINTERHAGER. *Aluminium,* Vol. 21, Mar. 1939, pp. 210-213. Review plus original research. Degasification of cast Al by the hot-extraction method removed about 0.2-1 cc./100 g. metal. If degasified Al is reexposed to H under atmospheric pressure, a true equilibrium between pressure and temperature for H absorption exists; at 1000° C., about 4 cc./100 g. metal are absorbed. In deforming degasified Al, more gas is given off; by heating in vacuum—20-30 cc./100 g. Al, more than originally was given off. If an Al surface is bombarded by electrons, amounts of gas can be extracted (by applying sufficiently high potentials) as high as 200 cc./100 g. metal, even from technically gas-free metals. Two processes occur: An irreversible absorption of very intimately bound gas originating in the electrolytic deposition of atomic gases in the "nascent state," and a reversible binding of gases that occurs only in the melt, and depends on the temperature and represents an absorption of gas according to a solubility equilibrium. "Roll blisters" exemplify the effect of irreversibly absorbed gases, "casting porosity" that of reversible solubility equilibrium. When determining the gas content in Mg by hot-extraction, the metal sublimates under these conditions, energetically absorbs gases and decomposes atmospheric moisture to form H, which is adsorbed by the metal. Mg must, therefore, be repeatedly sublimated in vacuum. Gas determinations in Mg made under such conditions showed that even in solid Mg, considerable quantities of gas are contained; the absorption of gas changes only little in liquid Mg with increasing temperature and corresponds to about the H absorption of Al. Also, Mg releases considerable gas in its production, but the gas-metal bond seems to be less intimate than in Al. 9 references. Ha (9b)

A Study of Beta-brass in Single Crystal Form. WAYNE WEBB (Univ. Iowa) *Phys. Rev.,* Vol. 55, Feb. 1, 1939, pp. 297-305. Original research. The resistances of 20 single crystals of brass in the β-phase have been measured as a function of temperature from room temperature to about 550° C. for the purpose of studying the order-disorder phenomenon. The results obtained are compared with the theory of Bragg and Williams. The resistivities at 25° C. as a function of composition place the limits of the β-phase at 51.3 and 55.5 atomic % Cu. A study of the thermal e.m.f. of the crystals against Cu shows only a slight discontinuity in the second derivative of the e.m.f.-temperature curve at the temperature of complete disorder. The e.m.f. curves themselves are quite smooth. Young's modulus, E, for 10 of the crystals, measured at room temperature, gives the elastic constant S_{11}, (44.8×10^{-13} cm.^{2}/dyne) and the combination of constants, $2S_{12} + S_{44}$, (0.028×10^{-13} cm.^{2}/dyne). A graph of 1/E against the orientation function, $(l^2m^2 + m^2n^2 + n^2l^2)$ is linear. From it, the ratio of the maximum to minimum E is found to be 8.94. Below the elastic limit the stress-strain relation is linear with no permanent set nor hysteresis. WAT (9b)

Ternary Magnesium Systems (Magnesium-Dreistoff-Systeme) H. BAUR. *Metallwirtschaft,* Vol. 18, Feb. 17, 1939, pp. 145-149; Feb. 24, 1939, pp. 164-165. Review. Only 17 ternary phase diagrams of Mg have been investigated, some completely and others less so. The greater number of these have Al as one of the other two components. The projection of the equilibrium curves in space onto the ternary base are given for all 17 diagrams. Brief comments on each diagram, and where more recent data are available than when the diagram was first proposed, these are introduced. 61 references. [Though Mg ternary diagrams have been neglected in the past in comparison with some other metals, German workers are rapidly adding to our knowledge of these systems. At least 3 new diagrams have been advanced since this article was published.—G. A.] GA (9b)

The Supposed High-temperature Polymorphism of Tin. C. W. MASON & G. E. PELLISSIER (Cornell Univ.) *Metals Tech.,* Vol. 6, Apr. 1939, 12 pp. Literature review and original research. The evidence for and against a phase change in Sn above room temperature is critically reviewed, and the case for such a change is shown to be weak. X-ray photographs at several temperatures between 25° and 200° C., microscopic observations at temperatures up to the melting point, and a study of grain growth all indicated no phase change above room temperature. 56 references. JLG (9b)

Concerning the Reversible Transformation in Cu-Al Alloys between 7 and 16% Al (Sur la Transformation Renversable dans les Alliages Cuivre-Aluminium entre 7 pour 100 et 16 pour 100 d'Al) ANDRÉ BOUTILLIER. *Compt. Rend.,* Vol. 208, Jan. 30, 1939, pp. 361-363. Original research. Earlier dilatometric work is reviewed and new studies made by thermal analysis, resistivity measurements and X-ray diffraction. The previously-found reversibility of the transformation that occurs in Cu-Al alloys of about 12% Al was confirmed. See also *Metals and Alloys,* Vol. 10, Mar. 1939, p. MA 175 R/1. FHC (9b)

10 Properties and Applications

Including Relation of Properties to Engineering or Product Design. See also Section 8a and 11.

M. GENSAMER, SECTION EDITOR

Materials at the Automobile Exposition (Die Werkstoffe auf der Autoausstellung) ASTER. *Automobiltech. Z.,* Vol. 42, Feb. 25, 1939, pp. 104-108. Review. The chassis of one car contains 40 different types of iron and steel. The modern automotive industry uses about 100 different qualities. Cast crankshafts have the following properties: Tensile strength up to 121,000 lbs./in.^{2}; yield point 99,000 lbs./in.^{2}; bending fatigue strength 31,400 lbs./in.^{2}; torsion fatigue strength 22,800 lbs./in.^{2} The corresponding values for cast iron crankshafts are: Tensile strength 47,000 lbs./in.^{2}; bending fatigue strength 8,500 lbs./in.^{2}; torsion fatigue strength 8,500 lbs./in.^{2} Cast crankshafts stand up in Diesel engines and also in double-piston motors. Great progress is reported in the working of light alloys. It is possible to work Al-Cu-Mg almost as well as sheet-iron for deep-drawing. "Stretch-drawing" is one of the processes used. The sheet is held in clamps while a wooden stamp forms it slowly by pressing against it. The blade ends of airplane propellers are made this way. This process is economical for relatively small numbers of pieces (500); the wooden tool is cheap and can be made very easily. Rubber parts are used in a tool for flanging which, together with the sheet, bends around corners in the die under suitable pressure. Other light-metal parts are made in a drop-forge using dies made from Mg-Al-Zn alloys. This metal is used because it can be easily remolten and cast from cheap wooden molds. Light alloys are used extensively for die casting. This process is economical only for large quantities. Parts requiring a great deal of machining, or requiring a great deal of allowance when cast in sand or chill molds, may be die cast to advantage in lots of 500 pieces. Usually the economic limit is between 1000 and 1500 pieces. Alloys used for die casting are: Mg-Al-Zn, Al-Mg, Al-Cu, Al-Cu-Ni, Al-Si, Al-Si-Ni and various other special die casting alloys. The life of the dies is around 25,000 castings for Al-alloys and up to 100,000 castings for Mg alloys. The upper weight limit is 5 kg. for Mg alloys, 4 kg. for Al pieces. Compound-castings are made; *e.g.* pulleys with propeller blades, the V-belt pulley being made from steel sheet, the hub and blades being made from Mg-die casting. Recently, a new bichromate pickling process ("Elomagieren") has been developed that allows effective surface protection for die-cast parts. Motor casings and cylinder heads can be made from Al-Si for gasoline, Diesel and double-piston engines for airplanes, racing cars, etc. Worm gears for motor cars are successfully made from an Al-alloy; it is not equivalent to bronze, but, taking into account a 25% lower carrying capacity, such worms have stood up in tractors without failure or excessive wear up to 100,000 miles. Bronze bearing bushings are being replaced more and more by thin steel bushings with Cu-Pb lining. Light metal bearings have not proved satisfactory except in a few instances. Cu-plated seamless steel tubing is used for fuel lines saving Cu and increasing pressure resistance at the same time, which is advantageous for injector lines in Diesel engines. Heating coils in glow-plugs can be made from Cr-Al-Co-Fe alloy instead of 80% Ni-Cr. A process is mentioned that permits the covering of sheet metal with a rubber-like, sound-absorbing coat by means of a spray gun. RPS (10)

Anti-friction Metals. (Les Métaux de Frottement) *Métaux,* Vol. 11, Dec. 1936 (actually published in Dec. 1938), pp. 225-327. This entire issue of this magazine (now *Métaux et Corrosion*) is given over to the subject of bearing metals—a subject selected back in 1936 to signalize the transition from *Métaux,* a journal on "special steels, metals and alloys", to *Métaux et Corrosion,* a periodical devoted primarily to corrosion problems, the wear of metals being considered a case of mechanical corrosion. According to the editor, the 2-year delay in publication was caused primarily by large increases in printing costs that necessitated reduction of the number of pages originally planned and entailed much condensation and rewriting—even of type-set material. The issue consists of 12 articles, each reviewing some narrower phase of the general subject. A. Roux reviews modern theories of wear; L. Guillet (Jr.) discusses wear testing; A. Sourdillon presents, in 21 pages, a broad general review of anti-friction alloys, covering Sn-, Pb- and Cd-base alloys; R. Cazaud gives special attention to Pb-Sn-Sb-Cu alloys; the anti-friction properties of brasses, bronzes, Cu-Pb alloys, and graphitic and porous bronzes are covered by P. Laurent; J. Galibourg, the organizer of the "symposium", discusses steel-against-steel friction; L. Persoz reviews the effects of nitriding and of metallic cementation on wear and frictional properties; M. Ballay discusses the bearing properties of cast iron, both plain and alloyed; J.-J. Baron surveys Al-base alloys for anti-friction service; the bearing applications of graphite are reviewed by G. Mandran; R. Gourdon contributes an article on the erosion of metals by "intentional friction" (friction applied for a purpose, *e.g.* to generate heat); and a brief section on service conditions under which bearing metals perform is written by P. Viandon. [There is practically no original research in the issue; nearly all of the articles are reviews and surveys, and only a few can be considered up-to-date in the information presented.—F.P.P.] FPP (10)

The Sintering of Some Metals (Ueber das Fritten einiger Metalle) W. BAUKLOH & G. HENKE. *Metallwirtschaft,* Vol. 18, Jan. 20, 1939, pp. 59-61. Original research. Experiments on sintering Al to Al, Al to Cu, Cu to Cu, Cu to Ni, Ni to Ni, Fe to Fe, Fe to Ni and pure Fe to steel were conducted in vacuum, H and N atmospheres. Half tensile specimens of the various metals were sintered together under pressure after careful preparation of the interface. Sintering was carried out at various temperatures for 2 hrs. It was determined that sintering, with the exception of Cu-Ni and Cu-Fe, starts at lower temperatures in a vacuum than in H or N atmospheres. The differences in the beginning of sintering in vacuum and H atmosphere is greater the lower the melting point of the metals being sintered and the higher the vapor pressures of the metals at the sintering temperature. In no case did the strength of the sintered tensile bar reach that of the weaker metal taking part in the bond. This is ascribed in part to the varied orientation of the crystals on the surface being joined, the uneven expansion of which prevents perfect contact. The atmosphere influences only the temperature for the beginning of sintering; strength of bonds produced at higher temperatures is independent of atmosphere. GA (10)

Modern Production of Stationary and Portable Compressed Gas Containers, and their Behavior in Liquefied and Condensed Gases (Neuzeitliche Herstellung ortsfester und beweglicher Druckgasbehälter und deren Verhalten gegenüber verflüssigten und verdichteten Gasen) N. CHRISTMANN. *Chem. Fabrik,* Vol. 11, Oct. 26, 1938, pp. 486-493. Descriptive. Production of light metal flasks (Lautal, Bondur and Duralumin) is described. Corrosion tests of Lautal vessels in O_2 and water under pressure indicated that corrosion occurred by formation of and attack along fissures. By coating the inner walls with corrosion resisting lacquer and the outside with aluminum bronze, corrosion resistance was improved. Storage of liquid propane and butane in gas-welded containers can be accomplished without difficulty. Results of tensile and impact tests on gas-welded specimens are given. Seamless containers of low alloy steel are used for highly condensed gases, such as city gas. 10 references. PCR (10)

Upon What Do the Proportional Limit and Tensile Strength of a Material Depend? (Von was hangen Fliessbeginn und Bruchfestigkeit eines Werkstoffes ab?) O. FÖPPL. *Mitt. Wöhler-Inst.* No. 35, 1939, pp. 56-70. Discussion. Axial loading and loading in bending are discussed from the point of view of stresses and deformation, leading up to appraisal of static and dynamic toughness and brittleness. Hardened steel has both static and dynamic brittleness, wrought Fe has static and dynamic toughness, precipitation-hardened Al alloys have static toughness and dynamic brittleness; cast iron has static brittleness and dynamic toughness. The distribution of stress in static bending depends on the ratio of elastic to plastic deformation, and this ratio governs the appraisal of a material as to static toughness or brittleness. Dynamic toughness depends on a similar ratio, in which the measure of plastic deformation is taken as the damping at the endurance limit. HWG (10)

Some Reflectivity Relationships of Individual Metals to Electroplated Metals. LIONEL CINAMON. *Metal Ind., N. Y.,* Vol. 37, Mar. 1939, pp. 111-114; Apr. 1939, pp. 168-170. Surfaces respond to light in 3 ways: diffuse reflection, specular reflection and diffraction. Diffuse reflection is caused by an uneven surface and is reflection in all directions; specular reflection is that of a smooth plane surface throwing incident light back as reflected light with the angle of incidence equal to the angle of reflection; light thrown on a surface having fine, close, uniformly spaced scratches is dispersed into the spectrum, and is known as diffusion. The better the finish of electroplated surfaces the less the proportion of dispersion or diffractive reflection, and therefore the higher the specular reflection. A plate having a high spectral reflectivity in the red and orange will do a better job when used as a reflector for fog or smoke penetration, than a white reflector with an amber lens. A reflectometer for determining the relative effectiveness of various electro plates as reflectors was constructed. This consisted of a source of constant parallel light, the reflecting surface set at 45° angle to the incident beam and a photronic cell device for measuring the reflected beam. Brass was used as a base metal for the electroplates. Silver was used as a standard and given a value of 100%. The following values were obtained on white light reflectivity: Al 87%, Rh 85.6%, Cd 79%, Ni 79% and Cr 77%. Metals only partially absorb colors and reflect the balance of the spectrum. Explanations are given for the blueness of Cr, the yellowish cast of Ni and the redness of Cu. From data given in the form of curves showing the percent relative reflectivity of the various wave lengths in Angstrom units, the formation of alloys having the desired color or for matching color of deposits can be accomplished. CBJ (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

Exact Measurement of the Specific Heat and Other Physical Properties of Solid Substances at High Temperatures. XXXI. The Specific Heat, Electrical Resistance, Thermoelectric Behavior and Thermal Expansion of Electrolytic Iron. F. M. JAEGER, E. ROSENBOHM & A. J. ZUITHOFF. *Rec. Trav. Chim.,* Vol. 57, Dec. 15, 1938, pp. 1313-1340. In English. Original research. The changes occurring in pure Fe at various temperatures were studied by thermal and electrical methods. The transition at the Curie point is a gradual one, and starts far below 760° C. The inner condition of the β-Fe thus formed is considered to be still in a disturbed and indefinite state between 760° and 940° C. The same holds for γ-Fe above the transition temperature at 906° C. Between 120° and 190° C., α-Fe exhibits another change of its inner condition, the true nature of which is unknown; but this effect is apparently not accompanied by a modification of the crystalline structure. The change at 760° C. is accompanied by a considerable contraction of the specific volume of the metal. Probably none of the successive phases of Fe is in a state of completed inner thermal equilibrium. The different phenomena manifesting themselves at the transition temperatures A_2, A_3 and A_4 with respect to the specific heat, electrical resistance thermoelectric properties and the thermal expansion of Fe are described. Special phenomena are reviewed which as the general result of numerous observations on different metals and alloys, have proved to be truly characteristic for phase-transitions occurring in solid media. Attention is called to the existence of transition intervals and of intermediate, physically non-homogeneous phases. An apparently "stabilized" character of the latter as the result of strongly retarding influences may be obtained, which cannot be distinguished from a real state of inner equilibrium, to which no thermodynamic reasoning can justifiably be applied. For Part XXX, see also *Metals & Alloys,* Vol. 9, Oct. 1938, p. MA 617 L/8. EF (10a)

The Longitudinal Magneto-resistance Effect at Various Temperatures in Iron-silicon Alloys. YUKI SHIRAKAWA. *Sci. Repts. Tohoku Imp. Univ.,* Vol. 27, Jan. 1939, pp. 255-277. In English. Original research. Alloys of electrolytic Fe, and Si of 99.15% purity, ranging from 0.05% to 21.71% Si, were prepared in the form of wires 1.5-6.4 cm. in length by 0.33-0.77 mm. in diameter. These specimens were placed in an anti-inductively wound nickel-chromium tube furnace and the magnetic resistance measured over a wide range of temperatures. The maximum change in resistivity owing to magnetization is displaced toward higher temperatures with increasing amounts of Si, but the magnitude of the change in resistance decreases with increasing Si. The change in resistance of alloys containing more than 9.43% Si is negative at all temperatures and magnetic fields, and goes through a minimum below room temperature. The minimum in alloys containing from 14.6 to 16.03% Si is very deep and sharp, probably owing to the formation of the Fe_3Si superlattice. The magneto resistance-temperature curve for all specimens has a sharp negative minimum slightly below the Curie point. AUS (10a)

How Zirconium helps make sound 12 to 14% Chromium Steels

ZIRCONIUM is being successfully used as a final deoxidizer in 12 to 14 per cent chromium steels. This treatment thoroughly cleanses the steel, helps remove dissolved gases, and eliminates pinholes and porosity in ingots and castings. A sound, dense steel results. The form of zirconium most effective for this purpose is 35 to 40 per cent zirconium alloy.

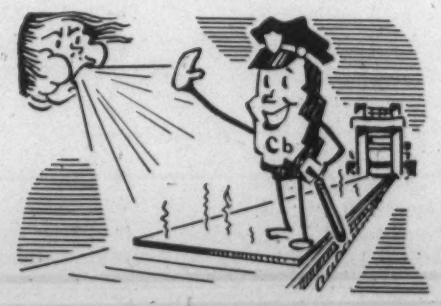
Ask to have one of our metallurgists call and explain further how you can improve your 12 to 14 per cent chromium steels with zirconium. He will gladly help make your use of this and other "Electromet" ferro-alloys profitable, without obligation. Electro Metallurgical Company, Unit of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York, N. Y. In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

Items of Interest about other "Electromet" Ferro-Alloys

High-Nitrogen Ferrochrome Improves High-Chromium Steel Castings — High-nitrogen ferrochrome adds both nitrogen and chromium to steel. A small per cent of nitrogen in cast steels containing over 20 per cent chromium greatly refines grain size, inhibits objectionable grain growth at high temperatures, materially increases strength and toughness and effects a slight increase in hardness.

Calcium-Manganese-Silicon Eliminates Pinholes — In repeated tests, calcium-manganese-silicon used as a ladle deoxidizer has proved beneficial for counteracting gases which penetrate the steel when it is being cast. The elimination of these gases reduces the formation of pinholes in the castings.

Use Columbium to Counteract Air-Hardening in Plain Chromium Steels — Columbium in small amounts in wrought plain high-chromium steels coun-

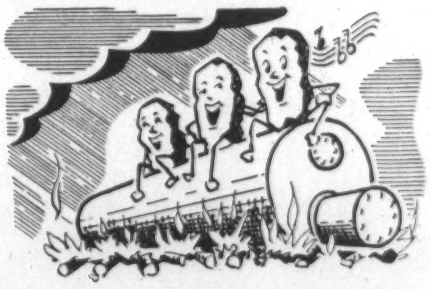


teracts air-hardening. As a result the steels are soft in the hot-rolled condition. The annealing period required to further improve the properties of the metal is shorter than when no columbium is present.

Chromium Gives Longer Life to High-Manganese Steel Castings —The addition of 1 to 3 per cent chromium to 12 per cent manganese-steel castings increases the initial hardness, which is desirable for wear resistance where impact is not severe enough to work-harden plain manganese steel.

Calcium-Silicon Improves Electric Furnace Steels — Calcium-silicon used as a ladle deoxidizer in wrought steels made in the electric furnace increases the soundness of the steel and improves its hot-working properties.

Columbium or Titanium Widens Use of Austenitic Stainless Steels — When austenitic stainless steels contain columbium or titanium, they are free from intergranular corrosion even after being



held at temperatures ranging from 750 to 1,650 deg. F. for long periods. It is possible to use these steels without annealing after welding with columbium-bearing welding rod.

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PRODUCTS OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

The Effect of Arsenic on Steel. *Metallurgist* (Suppl. *Engineer*) Feb. 1939, pp. 3-7. Correlated abstract, with particular attention to new data by E. Houdremont, H. Bennek & H. Neumeister (See *Metals and Alloys,* Vol. 10, Jan. 1939, p. MA 54F/3; also, *Tech. Mitt. Krupp,* July 1938, p. 101). Steels with As ranging from 0.02 to 1.24% were made and tested. With a 0.14% normalized mild steel arsenic up to 0.4% was almost without influence; above that, tensile strength and yield point rose with increasing As content, elongation remained almost unchanged, while reduction of area and impact figure showed a considerable fall. With a medium 0.46% C steel—ingots forged, test specimens quenched in water at 820° C., tempered for 1/2 hr. at 500° or 600° C. and cooled in air or in a furnace—the elongation yield point and tensile strength (in spite of some irregularities) were not much affected by As up to 1% under any of these conditions. Reduction of area showed a clear diminution with increasing As content; the fall was unmistakable even with 0.15% As and was more pronounced in the series tempered at 500° C. Impact figures declined slightly in steels with high As content. With a 0.33% C, 3.70% Ni, 0.75% Cr steel—oil-hardened from 820° C., tempered at 500° or 600° C. for 1/2 hr. and cooled in air or in the furnace—there was a rise in yield point and tensile strength up to 1% As that was more evident in the steels tempered at 600° C. than in the harder specimens. Ductility values were lowered by the addition of As to a greater extent than in the C steels. Impact figures were unchanged up to 0.15% As, but then fell. Elongation showed a marked fall when the As exceeded 0.8-1.0%. The steel with 1.3% As was so brittle that it broke prematurely with practically no elongation or reduction of area. The steels were considerably worse in this respect after slow cooling, though the impact figures were already so low that slow cooling made little difference. With a 0.33% C, 1.10% Cr, 0.23% Mo steel—heat treated similar to the foregoing Ni-Cr steel—there was no appreciable change in properties in the range examined, that is 0.04-0.18% As. With a Cr-Mo creep-resisting steel (0.16% C, 0.88% Cr, 0.47% Mo) the yield point, maximum load and elongation of these steels remained unaltered when the As content rose from 0.04% to 0.41%. The impact value showed a tendency to temper brittleness when a treatment involving slow cooling or prolonged heating was applied. With a C tool steel (0.95% C, 0.07% Cr) the influence of As on hardenability and susceptibility to overheating was determined. Fractures showed that As has no effect on depth of hardening up to 0.2%. Beyond that, depth of hardening diminishes with increasing As content. Moreover, the hardened zone loses its velvety appearance and becomes matt gray while the core shows a sharp edged brittle fracture instead of the tough fibrous appearance of the low-As steels. An increase in susceptibility to overheating set in at about 0.2% As. Corrosion tests on mild steels containing 0.04, 0.18 and 0.24% As in conductivity water, in an industrial atmosphere and in acid vapor, failed to establish any marked effect of As either in improving or lessening corrosion resistance. Pickling studies showed that AsH_3 gas was evolved when the As steels were pickled in 1-10 H_2SO_4 without an inhibitor; with an inhibitor, no fumes were evolved until the metal itself was attacked. Large scale tests with various methods of welding, showed that steel with 0.24% As could meet all present-day demands. The deleterious effect of 1.24% As was very pronounced. VVK (10a)

Dies for Plastics—Advances in Metals for Dies—New Tools—Plating on Plastics. L. SANDERSON. *Can. Metals Met. Inds.,* Vol. 2, Jan. 1939, p. 14. Four main types of die steels for plastic materials are: (1) High-C high-Cr steel containing certain other elements furnishing an increase of toughness and resistance to wear; (2) a high-Cr steel containing no Ni which, after suitable heat-treatment, possesses 100 tons/in.^{2} max. stress, 95 tons/in.^{2} in yield point, 7% elongation on 2 in., 15-20% reduction of area, Brinell hardness 444; (3) a Cr Fe with lower C than the last class and supplied in an annealed condition and with a Brinell hardness of only 156; and (4) a special steel containing Cr and V, which can be employed for either hobbing or direct cut molds. The building up of worn parts of cutting tools and dies is an interesting new process. Other new processes mentioned include: A patent file for plastic materials, and a new process for plating glass, wood, rubber, porcelain, molded atricles, etc., with Ag, Ni or Cr. WHB (10a)

Materials for Reflecting Surfaces. W. IRBY. *Mech. Eng.,* Vol. 61, Feb. 1939, pp. 137-141. Principal requirements for illuminating devices, *i.e.* high initial reflection and ability to maintain reflectivity in service, are discussed for glass, silvered glass, glazed porcelain, aluminum, stellite and rhodium. The respective reflectivity coefficients are 0.85-0.87, 0.75-0.80, 0.66-0.76, 0.62-0.64 and 0.70-0.72, depending on the wave lengths of the light. An improved silvered-glass floodlight reflector is described in which the silvered surface is covered with porcelain enamel, making the reflector heat- and weather-resistant. Ha (10a)

Properties of Some Free-machining, Lead-bearing Steels. J. H. NEAD, C. E. SIMS & O. E. HARDER. *Metals and Alloys,* Vol. 10, Mar. 1939, pp. 68-73; Apr. 1939, pp. 109-114. Original research. The addition of Pb to steel results in considerable improvement in machinability. As little as 0.10% Pb is beneficial, and the effect increases up to almost 0.50%. Slightly under that amount appears to be the limit for uniform dispersion. The data in this article refer to steels containing 0.20-0.25% Pb, the optimum range. Chemical analysis clearly reveals this amount of Pb, although the microscope fails to show the Pb present as a separate phase or discrete particles. Also, X-ray diffraction patterns prove that the Pb is not dissolved in the ferrite. Chemical analyses of split ingots show a surprising freedom from Pb segregation; this uniform dispersion, coupled with the lack of evidence of solid solution, indicates that Pb may be present as submicroscopic particles—a hypothesis that is borne out by the slightly smaller grain size of Pb-treated steels. The data given on screw stock steels show that the Pb-bearing steels are not brittle, and except for their enhanced machinability, are scarcely distinguishable from similar Pb-free steels. Long-time room temperature aging showed no appreciable change in impact properties. The presence of Pb in screw stock steels does not alter their response to cold-drawing. Endurance tests on Pb-bearing and Pb-free S. A. E. 1045 steel showed almost identical behavior, as did strength, hardness and ductility tests made on quenched (oil and water) and tempered samples of the same steel with and without Pb. Mechanical properties of several low-C S. A. E. Cr, Ni, Ni-Cr, Cr-Mo, Ni-Cr-Mo, Ni-Mo, Cr-V and Cu alloy steels, normalized and also after 7% cold reduction, showed negligible differences in mechanical properties because of the Pb content. The Pb-bearing steels are only slightly (in some cases almost imperceptibly) shallower hardening than their Pb-free counterparts; carburizing the leaded steels also resulted in practically the same surface hardness, in each case, as was obtained by carburizing those without Pb. Only the machinability seems to be affected, and this favorably, by Pb additions. Machinability data taken largely from regular production tests on automatic machines, at systematically varied speeds and feeds, show machinability improvement from 25 to 75% ascribable to the presence of Pb; in one case, for example, the time required to machine a given part in production was reduced from 17 min. with S. A. E. 1020 to 5 min. with Pb-bearing S. A. E. 1115. Experience of Inland Steel Co. shows that under intelligent handling there is no additional health hazard introduced in the melting or machining operations by the use of Pb, nor is there real reason to fear any damaging effect either on refractories or on new steel melts through the adventitious use of Pb-bearing scrap in melting. FPP (10a)

Effect of Titanium and Vanadium on Forged Pearlitic Manganese Steel. GEORGE F. COMSTOCK (Titanium Alloy Mfg. Co.) *Iron Age,* Vol. 143, Feb. 16, 1939, pp. 27-32. Original research. A series of small heats of wrought pearlitic Mn steel with low-C content was made in basic-lined arc furnaces and treated with one or both of these elements. In Ti steels, ferrotitanium was added in ladle, while ferrovanadium used for V steels was added to some heats in ladles and to others in furnace. No Al was used. Properties were investigated by tensile and Izod impact tests, and grain size determinations. Results obtained show that: (1) V has a hardening effect on forged pearlitic Mn steel, usually increasing strength and sometimes reducing ductility and impact resistance. Ti has a softening effect and decreases the strength, but gives decidedly higher ductility and impact resistance. (2) Beneficial effect of Ti on ductility and impact resistance is consistently greater than that of V. (3) Both Ti and V show a tendency to reduce grain size, and often to maintain a fine grain at normalizing temperatures as high as 1950° F., but Ti is more effective in this than V. In these steels with about 1.7% Mn, it required more than 0.02% residual Ti to give reasonable stability of grain size at higher temperatures, 0.03-0.10% being satisfactory. Considerably more V was needed for the same purpose, even 0.10% in one steel failing to prevent coarsening at 1750° F. (4) When Ti was added with V, effect of the latter was intensified. (5) With Ti substituted for a part of high V addition, such as 0.3%, properties generally were not impaired. Includes graphs giving variations in physical properties, as well as photomicrographs showing microstructures of these steels. VSP (10a)

Experiments on Reversible and Irreversible Wall Shifts between Weiss Regions of Antiparallel Direction of Magnetization (Versuche über reversible und irreversible Wandverschiebungen zwischen antiparallel magnetisierten Weissschen Bezirken) M. KERSTEN. *Z. tech. Physik,* Vol. 19, Dec. 1938, pp. 546-551. Research. Relates to reversible and irreversible wall shifts in the special case when all Weiss regions are oriented in the direction of the external field, so that any 2 contiguous regions differ in their direction of magnetization by 180°, *i.e.* are antiparallel. This condition prevails in a ferromagnetic body of positive longitudinal magnetostriction subjected to tension, whose hysteresis loop is almost strictly rectangular, the reversal of magnetization taking place in a single large Barkhausen effect. ORS (10a)

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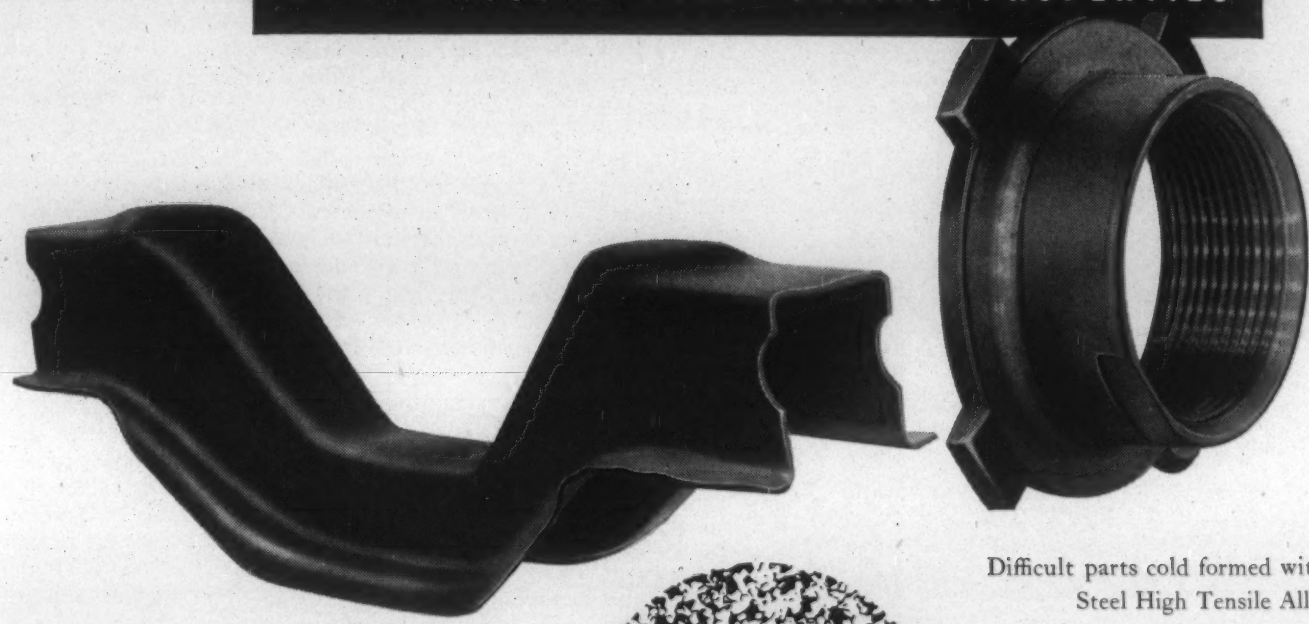

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Cast Irons for Rolls of High-hardness and High-wear Resistance. K. BUNIN. *Teor. i Prac. Met.,* No. 11, 1938, pp. 52-60. In Russian. Research. A series of experiments was conducted with irons containing 0.5-7.5% Mn, 1-4% Si and 0-0.9% Cu used in different combinations in order to produce rolls having properties similar to those of rolls made of 1.0% Cr, 4% Ni and 0.3-0.5% Mo irons (Ni-Hard type). The melts were made in an oil-fired crucible furnace and checked by pouring on a chill plate and examining the fracture produced. With Si between 0.52 and 2.89%, addition of 1.5-2.0% Mn has no effect on the depth of chill, but makes the test specimen mottled throughout. With 1.81-2.08% Si, the influence of Mn is more pronounced, so that with 7% Mn the specimens are chilled throughout. When Si is under 0.62%, the depth of chill increases rapidly; 1.5% Mn produces a pronounced chill and 4.5% Mn chills throughout. In irons with 3.18 and 7.43% Mn test bars with 1.0-1.25% Si were chilled throughout, larger amounts reducing the chill, so that 1.25-1.75% Si would be the desired range for producing chill 45-60 mm. thick in high-Mn rolls. The depth of chill is reduced by Cu in Mn irons, its greatest effect being at 1.5%. Amount of Si required for a proper chill depth in Mn-Cu irons containing 2.6% Mn and 0.55% Cu is 1.0-1.5%. About 7-8% Mn is needed to prevent pearlitic decomposition of 3.0-3.3% C and 1.5-1.75% Si, as is shown by microscopic examination. A maximum hardness of 58 Rockwell C is obtained in 1.8-2.0% Si irons by the presence of 6% Mn, further increase lowering the hardness. In 7.7% Mn irons, hardness is increased continuously by the addition of Si, until the latter reaches 1.6%, after which hardness drops rapidly. Ni-Hard iron was found to be slightly harder than the proposed alloys at room temperature, but softer at elevated temperatures; the latter determinations were made with a Brinell machine. Ni-Hard was much more uniform than the new alloys in tensile properties, but showed more rapid wear than Mn and Cu-Mn irons, the relative figures were 0.819, 0.467 and 0.256 mgs./cm.^{2}/hr., respectively. Scaling resistance at 600° C. of Mn irons was low, that of Cu-Mn was about the same as that of Ni-Hard. (10a)

The Alloys of Iron with the Metals of the Platinum Group (Les Alliages du Fer avec les Métaux de la Famille du Platine) M. FALLOT. *Ann. Phys.,* Vol. 10, Oct. 1938, pp. 291-332. Original research. A study of the expansion of alloys of Fe with Ir, Os and Ru within the restricted ferro-magnetic range showed that its extension coincides with solid solution range of the body-centered lattice. As to Rh, this structure prevails up to very high concentrations of Rh. In the binary alloys of Fe-Pt and Fe-Pd ferromagnetic alloys are met having face-centered cubic lattices. The phase transitions were located by the determination of Curie points and of the transformation points and confirmed by X-ray analysis. The properties of the Fe-Pt and Fe-Pd alloys are similar to those of Fe-Ni alloys. In the binary systems Fe-Ir, Fe-Pt, and Fe-Rh the mean atomic moment increases with the noble metal concentration, but the alloys of Fe with Pt and Rh are comparable with Fe-Cr alloys in this respect. EF (10a)

Increase of the Specific Load under Tension, Compression or Buckling of Welded-in Steel Tube Fuselage Struts in Airplane Construction by Suitable Selection of Structural Steel and by Proper Design (Erhöhung der spezifischen Belastbarkeit bei Zug, Druck und Knickung von eingeschweissten Stahlrohr-Fachwerkstreben im Flugzeugbau durch Massnahmen werkstofftechnischer und konstruktiver Art) I. MÜLLER. *Luftfahrtforschung,* Vol. 16, Jan. 10, 1939, pp. 14-17. Original research. Presents testing data on welded Cr-Mo steel tubes which were submitted to heat treatment after welding. American, German and Swedish steels were employed. The annealed tubes had a tensile strength of 85,000 lbs./in.^{2} which could be doubled by heat treatment. Considerable weight savings could be achieved by reenforcing the ends of the tubes. The experimental results are graphically presented. EF (10a)

Development of Metal Wool Brake Linings (Entwicklungspraxis von Metallwolle-Bremsbelägen) RUDOLF OSWALD. *Deut. Motor-Z.,* Vol. 16, Feb. 3, 1939, pp. 6-8. Original research. Experiments with brake linings of steel wool embedded in synthetic rubber are reported. The temperatures developed with this composite material used in place of asbestos linings were recorded with rail vehicles. The wear of the new metallic brake linings has been considerably decreased and their use in aviation and automobile industry is predicted. For previous installment, see also *Metals and Alloys,* Vol. 10, Feb. 1939, p. MA 114 L/6. EF (10a)

Stainless Steel Ignition Cable. *Automotive Ind.,* Vol. 79, Dec. 3, 1938, p. 714. Descriptive. In the development of a new automobile ignition cable, stainless steel wire has been found to possess four properties superior to those of present cable materials. These desirable properties are: (1) low capacitance between engine and cable because of the reduction of cable cross-section permitted, thus lowering drain on battery. (2) high electrical resistance, which damps out all but major oscillations, and thus reduces plug wear, (3) low heat conductivity which saves the rubber insulator, and (4) high strength. CMH (10a)

Chromium-molybdenum Steels. *Metallurgist* (Suppl. *Engineer*) Feb. 1939, pp. 13-15. Correlated abstract. Investigation of 21 steels, some containing Ni and some free from Ni, was made by A. Pomp & M. Hempel (see *Metals and Alloys,* Vol. 9, Apr. 1938, p. MA 249 R/3) with the object of assessing their suitability for use as high-tensile constructional materials. In the upper range of tensile strength (150,000-165,000 lbs./in.^{2}) steels containing 2.5-4.5% Ni with addition of W and Mo gave no better results in bars up to 3 in. diameter than low-Ni steels with addition of Cr, Mo and V. For tensile strengths of 115,000 to 130,000 lbs./in.^{2}, the Ni-free steels proved quite satisfactory. The Cr-Mo steels containing up to 3% Cr were especially promising. In continuation of this work, A. Pomp & A. Krisch (see *Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 731 R/8) have carried out tests on commercial specimens of 6 Cr-Mo steels of the types 0.22-0.45% C, 0.9-1.2% Cr, 0.15-0.25% Mo; 0.38-0.45% C, 1.6-1.9% Cr, 0.3-0.4% Mo, 0.2% V; 0.24-0.34% C, 2.3-2.7% Cr, 0.2-0.35% Mo, 0.2-0.35% V; and 0.24-0.35% C, 1.8-2.7% Cr, 1.2-2.3% Ni, 0.2-0.4% Mo, 0.2% V. Special attention was given to the degree of depth hardening, after heat treatment under various conditions, of specimens of different sizes. General conclusions were that the field of utility for the last mentioned steel seems to be in giving high tensile strength in medium or relatively small sections, while the 3.0% Cr, 0.6% Mo and the 2.5% Cr, 0.3% Mo, 0.2% V steels offer the best alternatives to Ni-Cr-Mo steel for material that has to be treated in large masses. VVK (10a)

What About Grain Size? CARL L. SHAPIRO. *Iron Age,* Vol. 143, Mar. 16, 1939, pp. 25-27; Mar. 30, 1939, pp. 23-27; Apr. 6, 1939, pp. 33-37. Extensive review. Various procedures used for determining austenitic grain size are described. Austenitic grain size is denoted by a cementitic with most attention to the McQuaid-Ehn test, to etching at elevated temperature, with subsequent room temperature microscopic examination, and to the Shepherd penetration fracture test. The molten salt method of Schempp and Shapiro consists of immersing polished specimen in a molten chloride at any temperature for 5-10 min., quenching in H_2O, washing in alcohol and examining for grain size. Tests for determining austenitic grain size in various types of steel are recommended. Discarding of the term "inherent grain size" is urged. The various factors that influence final austenitic grain size of any steel are: (1) Prior structure or initial grain size; (2) mechanical deformation (hot and cold work) that remains or is conferred upon it during austenitizing; (3) rate of heating to austenitic condition; (4) time and temperature of heating; (5) method of deoxidation; and (6) type of grain growth inhibitors resulting from deoxidation process. A summary is given of the influence of grain size variations upon physical properties and characteristics of steels, based mainly on published data. Emphasizes the fact that results are variable since they are influenced by melting, method of deoxidation, casting temperatures and prior mechanical and thermal treatments. VSP (10a)

Valve Materials. H. E. BLANK, JR. *Automotive Ind.,* Vol. 79, Nov. 19, 1938, pp. 673-676. Review. A history of the development of automotive valve materials is given. The properties desired in these materials are given and compared with advantages and disadvantages of valve materials now in use. Valve design is also discussed. A list of valve materials used in all 1938 and 1939 passenger cars is included. CMH (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

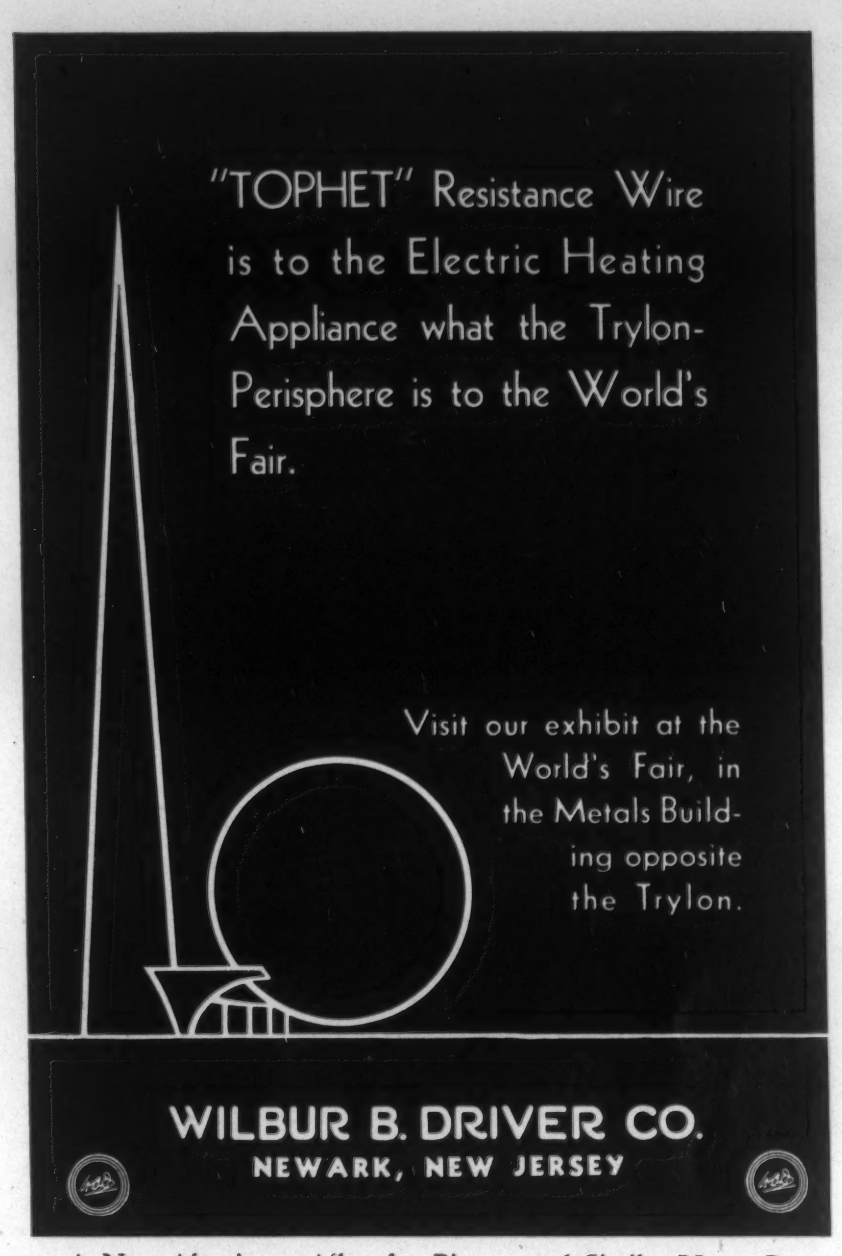
Information on Palladium-silver-gold Alloys for the User of these Materials in Dentistry (Wissenswertes über Palladium-Silber-Gold-Legierungen für den Verarbeiter dieser Werkstoffe in der Zahnheilkunde) KARL FALK. *Alba, Beiträge zur Kenntnis der Edelmetalle als Werkstoffe in der Zahnheilkunde,* 1938, pp. 16-28. Original research. Ni and Pd dissolve Au. Ni impairs the workability and casting properties of Au. Ag-Pd base alloys are more suitable as "white noble metal dental alloys." Ag-Pd-Au alloys are 30-35% lighter and thus more economical than Au-Ag-Cu alloys (60% cheaper). The plastic deformability and color permanence is about the same, but the Au-base alloys melt at 100°-200° C. lower temperature. The wear of the new Ag-Pd-Au alloys is smaller, owing to their greater hardness. They are readily attacked by HNO_3, and HCl produces "season-cracking" in hard worked alloys. 10% H_2SO_4 is recommended for pickling. Careful finish polish is essential for color preservation. The strength of a soldered joint is greater with slow cooling than with quenching. The Ag-Pd-Au solders do not corrode, but they have a greater tendency to become heterogeneous than Au-solders. A certain lack of fluidity does not interfere with the use of Pd-Ag-Au alloys; the natural tendency to overcome this low fluidity by overheating the melt, which spoils the alloy, should be avoided. EF (10b)

Magnesium Alloys in Road Vehicle Construction (Magnesiumlegierungen im Strassenfahrzeugbau) THEO. CLEFF. *Automobiltech. Z.*, Vol. 42, Mar. 1939, pp. 168-175. Practical. Mg-Mn alloys used in profiles and sheets are weldable and workable. Extensive working is done after heating by flame to 250°-330° C., the temperature, being controlled by crayon, soap, temperature, colors, etc. The weldability of alloy AM503 (0.2-0.5% Al, 0.1-0.3% Zn, 0.1-1.0% Mn, balance Mg) excels that of most light alloys. The strength properties of Mg alloys are sufficient: Only the notch-sensitivity is greater than that of high-strength Al alloys. The yield strength is high as Al alloys that are not heat treated, but the corrosion resistance of Mg alloys is lower. Contact corrosion at joints with other materials (heavy metal, wood) can be avoided by suitable insulation, *e.g.* elastic couplings, paper-fiber shims, etc. Atmosphere corrosion is counteracted by applying protective lacquer. Steel parts that come in contact with Mg alloys should be Cd- or Zn-plated. Pickled surfaces resist the influence of ordinary atmosphere; high salt content may, however, be detrimental. Mg alloys are generally used only for such parts that do not transmit main stresses. Local corrosion on such parts cannot do much harm in case the protective lacquer fails. Parts such as doors can be made from Mg alloys without restriction. Elements with thin cross sections are endangered by surface corrosion more than heavy parts. The service of such parts in coastal districts cannot be predicted from laboratory tests, and only field experience can serve to determine their life. This and the endurance properties are critical factors to be considered in making a choice between Mg and Al alloys. Some vehicle parts can be made from Mg castings, and typical examples are given in a bus trailer. Alternating stresses in some beams require the use of welded steel, but part of the load is carried by Mg alloy elements. Columns, stays and 1.5-mm. sheets for side walls and roof are made from Mg alloys. Extruded profiles are used. The floor, taking up some transversal stresses, is a 1.0-mm. corrugated sheet of Al-Mg alloys, as are girders above and below the doors. Details concerning structural changes for the adaptation of the light alloys are given. Wheels are made from Mg-Al alloy with a steel hub; about 50 lbs. in weight is saved. Hot working of Mg alloys is done on a commercial scale. In production of a single part the working of this alloy was more economical than if customary steel sheet was used. Welding of stressed parts is avoided for reasons of safety and economy. Longitudinal beams and webs of chassis for experimental truck trailers are also made from Mg alloys. The transversal beams are also pressed profiles. Ball steering crown and shaft are made from Mg castings, allowing perfect shapes. Only high-strength Mg or Al alloys are superior to steel in similar constructions. Girders carrying the rear axle are also Mg castings, which possess good deformation properties. [The examples given are experimental units. Some applications of Mg-alloys mentioned are very interesting, even though the application of these materials is partly motivated by the endeavor of Germany not to use imported materials.—R. P. S.] RPS (10b)

Lead Segregations in Nickel Bronzes. J. MARECHAL. *Metal Ind., London,* Vol. 54, Mar. 24, 1939, pp. 339-340. Orginal research. A study of the occurrence of Pb segregations in Ni-bronzes with varying Sn contents. Several series of alloys were cast containing 5, 6, 7, 8, 10 and 12% Sn, respectively. Of the samples cast, only those were retained that showed no Pb segregation on microscopic examination. Several samples were cast without Sn containing 1-4 Ni and 50-80 Pb. These showed no Pb segregation but were very plastic and, therefore, not considered. The amount of Pb that can be incorporated in a bearing bronze is determined by the Ni and Sn contents. The bronzes that respond best to conditions of good lubrication are those containing 5-6 Sn, 4-5 Ni and 32-35 Pb. Ni has the effect of dispersing the Pb particles and of shifting the appearance of Pb segregation toward the high Pb contents; both these effects increase the lubricating qualities of the bronze. The Pb content must not be increased beyond about 35%, as this makes the alloys too plastic and consequently too weak. RWB (10b)

Effects of Beryllium, Silicon and Cobalt on the Properties of Monel Metal. I. YA. BERKOVSKII & F. N. STEPANOV. *Metallurg,* Vol. 14, Feb. 1939, pp. 86-91. In Russian. Research. Be-Monel alloys containing 1% Be possess higher mechanical properties than Be bronzes with 2.5% Be or Ni alloys with 2% Be. The addition of Co to Be-Monel alloys with 1% Be did not improve the mechanical properties of the alloys. The strength of Monel metal was increased by 6% on the addition of 1.12% Si, while a further increase of Si up to 2.26% raised the strength of Be-Monel alloys with 0.87% Be by as much as 18%. BZK (10b)

Wrought Brasses and Bronzes. Properties and Applications. *Product Eng.,* Vol. 10, Apr. 1939, pp. 156-157. Practical. A table of 35 alloys is compiled, giving composition (Cu, Zn, Sn, Pb, with Si, Al, P, Fe and Mn as special additions), ultimate and yield strength, elongation, thermal conductivity, suitability for hot- and cold-working, methods by which each can be welded, chief characteristics and typical applications. Ha (10b)



A New Aluminum Alloy for Pistons and Similar Motor Parts (Eine neue Aluminiumlegierung für Kolben und ähnliche Motorteile) *Giessereipraxis,* Vol. 60, Feb. 12, 1939, pp. 70-71. Description of Al alloys for pistons and similar motor parts requiring relatively low heat expansion coefficient and favorable mechanical and physical properties. Depending on the particular application, these alloys contain 7-25% Si, 0.2-0.3% Mg, 0.5-6.5% Ni and 0.3-2% Cu. In general, the Al content is not below 80%. For pistons, the alloys contain about 14% Si, 2% Ni, 1% Mg and 0.75% Cu, and possess a heat expansion coefficient of about 19 x 10^{-6}/° C. between 20° and 100° C. The alloy possesses a Brinell hardness of 85 in cast state, but this can be increased to 125-130 by heat treatment. GN (10b)

The Mechanical Properties of Zinc-aluminium Alloys. W. BRONIEWSKI & W. KOWALSKI. *Aluminium & Non-Ferrous Rev.,* Vol. 4, Feb. 1939, pp. 79-81. Original research. The hardness of Zn-rich alloys is considerably increased by the addition of 3% Cu. The same addition also increases the tensile strength and hardness of Al-base alloys. In the hardened state the tensile strength is 64,000 lbs./in.^{2}, and the elongation 7%. The best balance of mechanical properties is obtained in a light Zn alloy containing 3% Cu and 14% Zn in the annealed state. Further investigation with various additions may bring this type of alloy to the mechanical property level of duralumin. For previous work see *Metals and Alloys,* Vol. 10, June 1939, p. MA 348 L/1. RPS (10b)

Palladium-silver-gold Dental Alloys (Die Palladium-Silber-Gold-Legierungen in der Zahnprothetik im Blickfeld der Indikationsstellung) ADOLF BÜCHE. *Alba, Beiträge zur Kenntnis der Edelmetalle als Werkstoffe in der Zahnheilkunde,* 1938, pp. 50-53. Review. The harmful physiological effects of "golden" Cu-Zn alloys as substitutes for dental Au alloys are described. The Pd-base Pd-Ag-Au alloys are stronger than Au-base dental alloys. The casting properties are good, and make possible the attainment of accurate dimensions. EF (10b)

Beryllium Alloys in Automotive Production. HARRY WILKIN PERRY. *Automotive Ind.,* Vol. 80, Feb. 18, 1939, pp. 185-189. Review of the uses and properties of Be-Cu alloys used in the automotive industry. The various types of heat treatment applied to such materials are given. The use of Be is limited to small parts, such as electrical contacts, requiring high strength, fatigue resistance and corrosion resistance, together with good electrical conductivity such as electrical contacts. CMH (10b)

Electric Resistance of Copper and Aluminum as Depending on Temperature up to the Melting Point (Temperaturabhängigkeit des elektrischen Widerstandes von Kupfer und Aluminium bis zum Schmelzpunkt) A. AVRAMESCU. *Z. tech. Physik,* Vol. 20, Jan. 1939, pp. 26-30. Original research. The electric resistance at various temperatures of VDE (Verein deutscher Elektrotechniker) Standard cold-drawn Cu or Al wires (composition not given), 2.5 or 4.0 mm.^{2} in cross-section, was determined and used in calculating their temperature coefficients of electric resistance and resistivity, defined respectively, as R_θ/R_o and ρ_θ/ρ_o, where R = electric resistance and ρ = resistivity at 0° C. (subscript o) and the test temperature (subscript θ). Since $\rho = Rs/l$, where s = cross-sectional area, l = length of the conductor, and since not only R but also s and l vary with the temperature, $\rho_\theta/\rho_o = R_\theta/R_o \cdot f(\theta)$ where $f(\theta)$ = coefficient of linear thermal expansion. In preliminary tests, the exact length, cross-sectional area, and electric resistance at room temperature of the 1.5-3.0 m. long specimens were measured, and from these their electric resistance and resistivity at 0° C. were calculated, using the temperature coefficient of electric resistance, α (0.00428 and 0.0040 ohms/° C. for Cu and Al, respectively), given by Lindeck *(Ver. deutsch. phys. Ges.,* Vol. 13, 1911, p. 65). In the main series of tests, in which the resistance at elevated temperatures were measured, the axial temperature variation within the furnace (which had an O-free N_2 atmosphere) was negligibly small; the maximum relative error was ± 1.2% in individual temperature measurements and could be reduced to ± 0.4% at 500° C. and ± 0.5% at 1000° C. by averaging the results of 3-4 repeats. The values of R_θ/R_o and ρ_θ/ρ_o are practically identical at temperatures up to 100° C., diverge gradually at higher temperatures, and differ by about 2% in the vicinity of the melting point of either metal. The results obtained with cold-drawn specimens varied as depending on their cross-section and thus have no general validity. Cold working has the same effect as impurities present in the metal, in that it raises the resistivity while lowering its temperature coefficient. The value of R_θ/R_o of cold-drawn Cu wire of 4.0 mm.^{2} cross-section increased with the temperature, up to 500° C., at the ratio of 0.00428, which is about 5% lower than that for the annealed material; above 500° C. the effect of annealing became increasingly noticeable, and from 700° C. on the values for cold-drawn and full-annealed material were identical. Since only cold-drawn conductor materials find use in electrical engineering, the determination of the temperature coefficient of electric resistance for all currently used cross-sections is held to be very desirable. The author's values agree closely with those of Northrup *(J. Franklin Inst.,* Vol. 117, 1913, p. 1) obtained on Cu with 99.71% Cu, suggesting that the author's material was of the same degree of purity. ORS (10b)

Researches on Magnesium Alloys. II. The Mechanical Properties and Corrosion Resistance of Mg-Mn-Al Alloys. H. IMAI, H. TAMURA & H. MIKASHIMA. *Nippon Kinzoku Gakkai-Si,* Vol. 3, Feb. 1939, pp. 47-53. In Japanese. Original research. Effects of Mn and Al on mechanical properties of Mg alloys were studied. Tensile strength, elongation and impact resistance are improved to some extent with addition of Mn up to 2%. The effects of Al on the mechanical properties of these alloys are more marked than Mn; the tensile strength increases with Al up to 6%, and elongation, reduction of area and impact resistance decrease rapidly. In alloys with less than 6% Al, the increase of hardness through heat-treatment is not noticeable, but the increase is marked with more than 8% Al, the best aging temperature was 230° C. Corrosion tests were made with water and NaCl solution. Mn addition above 0.3% is beneficial; 1% Mn in the cast state and 1.5% Mn in the heat-treated condition showed the maximum corrosion resistance. The resistance to water-corrosion is improved by Al, while in salt solution, alloys of 6% Al were most corrodible. For Part I see also *Metals and Alloys,* Vol. 9, Jan. 1938, p. MA 48 R/6. NS (10b)

Alloys of Nickel and Columbium. S. A. POGODIN & A. N. ZELIKMAN. *Metallurg,* Vol. 14, Jan. 1939, pp. 8-14. In Russian. Research. Ni-Cb alloys containing up to 70% Cb and insignificant amounts of Al were prepared by reducing the Ni and Cb oxides with powdered Al. The composition of the charge was calculated with the aid of unpublished experimental data on the heat effects of the aluminothermic process. The use of stoichiometric amounts of Al resulted in a high Al content (1.8-7%) in the alloys. To produce alloys with only traces of Al, the reduction should be accomplished with a deficiency (95% of the stoichiometric amounts) of Al. A study of the microstructure indicates that Ni and Cb form an intermetallic compound corresponding to Ni_3Cb. The hardness was determined for alloys containing up to only 40% Cb; alloys of over 40% Cb could not be tested because of their brittleness. The graphical representations of the specific resistance, hardness and temperature coefficient of resistance show that the highest concentration of the solid solution of Ni in Cb at 900° C. corresponds to 11-12% Cb. The addition of Cb to Ni raises the corrosion resistance of the Ni against HCl but it does not afford complete protection. The highest resistance against corrosion was shown by the alloy with 10.7% Cb. Future research is to include thermal analysis, solubility of Cb in solid Ni at various temperatures, and aging in the region of the α-phase. BZK (10b)

Magnesium Alloy Stampings as Modern Semi-finished Articles (Pressteile aus Magnesiumlegierungen als moderne Halbzeuge) R. SCHULZE. *A.-E.-G. Mitt.,* Mar. 1939, pp. 178-179. Practical. Mg alloys are increasingly used to replace brass and copper in Germany, and a very common method of shaping is the stamping of semi-finished articles. The material is preheated to 200° C. for simple shapes and to 320°-380° C. for more complicated ones. Dies have to be preheated to assure the right stamping temperature. Tolerance in size is usually ± 0.5 mm. Some parts have to be drilled, milled and machined. Higher speeds are possible with Mg than with Al alloys, although the corrosion resistance of the Mg alloys is frequently unsatisfactory. The best corrosion retarder is the use of protecting varnishes or lacquers. Submersion in oil is also a good method of protection. The mechanical properties of some common Mg alloys are as follows:

Designation	Comp. %	Condition	Yield Strength lbs./in.^{2}	Tensile Strength lbs./in.^{2}	Elong. %	Brinell Hardness 250-kg. load
MgAl 3	2-4 Al 0-1.5 Zn 0-0.5 Mn bal. Mg	without anneal	21,000 to 25,500	34,000 to 41,000	18-9	55-60
MgAl 6	6-7 Al 0-1.5 Zn 0-0.5 Mn bal. Mg	without anneal	25,000 to 31,000	38,000 to 47,000	16-10	60-65
MgAl 9	8-11 Al 0-1.5 Zn 0-0.5 Mn bal. Mg	without anneal	28,500 to 40,000	40,000 to 52,500	12-6	70-80
		homogen.	30,000 to 37,000	45,500 to 54,000	12-9	65-70
		hardened	37,000 to 42,500	51,200 to 61,000	6-2	85-95
MgZn	4-5 Zn 0-0.2 Mn bal. Mg	without anneal	22,500 to 25,500	34,000 to 40,000	18-14	50-6
MgMn	1-2.5 Mn bal. Mg	without anneal	11,000 to 21,000	25,500 to 34,000	8-1	40-50

JMN (10b)

Rolled Zinc. E. H. KELTON. *Metal Ind., N. Y.,* Vol. 37, Feb. 1939, pp. 79-80. Review. The properties of rolled Zn, including tensile strength, creep strength, hardness, and drawing and forming properties, are discussed. Strip or ribbon Zn is produced by rolling a cast bar in one direction to the required thickness. Sheet Zn is produced by pack rolling, *i.e.* rolling several sheets together until the desired dimensions are obtained. Rolled Zn ½ in. or more thick is classified as plate Zn; the width or length rarely exceeds 48 in. Strip Zn, available in thicknesses from 0.004 in. to 0.500 in., and in width from 0.200 in. to 20 in., is the class used in the fabrication of articles on automatic machines. Rolled Zn and its alloys are used to make eyelets, buttons, dry-battery cans, weatherstripping, jar tops, etc. Rapid formation of basic zinc carbonate film destroys the original bright surface, but inhibits further corrosion. Rolled Zn is easily soldered and plated. Rolled Zn alloys are also made, which are stiffer, stronger and have greater creep resistance than commercial grades of rolled Zn. The ultimate tensile strength varies from 18,000 lbs./in.^{2} for soft-rolled strip Zn to 50,000 lbs./in.^{2} for the hard-rolled alloys (composition not given). CBJ + FPP (10b)

Light-alloy Ship Construction. W. C. DEVEREUX & E. V. TELFER. *Inst. Naval Architects,* Adv. Copy, 1939, 12 pp. Descriptive and practical. The history of the light-alloy ship is reviewed, and the general metallurgical, heat-treatment, and cold-working properties of various grades of an Al-Mg alloy, referred to as Navalium, are discussed and tabulated. The structural problems of a low modulus of elasticity, low weight material are considered generally and in relation to ship construction, and the corrosion resistance of Navalium is compared with that of steel and is shown to be much better. Light-alloy design and construction are discussed, the influence of improved method on reducing the cost of Navalium is considered, and the cumulative structural gain of replacing steel and re-designing to produce a smaller ship fulfilling the same duty is stressed. JWD (10b)

Investigation of Light Metal Bearings in the DVL Testing Machine (Untersuchung von Leichtmetall-Lagerwerkstoffen in der DVL-Lagerprüfmaschine) G. FISCHER. *Luftfahrtforschung,* Vol. 16, Jan. 10, 1939, pp. 1-13. Original research. The performance as bearing materials of 7 Al and 4 Mg alloys (analyses, microstructure, hardness, and thermal expansion coefficients given) was determined. The shafts were partly in the heat treated or case-hardened condition. The rotation speed was 5 m./sec. and the testing temperature 120° C. The majority of tests refer to stationary loads, *i.e.* tests at constant polar pressure distribution and with rotating bearing. The tests determined the max. load capacity and the performance in long time tests, sometimes without lubrication. The bearing pressure in the long-time tests was uniformly 5,700 lbs./in.^{2} The load-bearing capacities of the harder Al alloys are mostly higher than 10,000 lbs./in.^{2} With a eutectic Al-Si alloy a mean bearing pressure of 13,100 lbs./in.^{2} could be obtained without difficulties. The rest of the bearing materials failed at pressures of 6,700-9,200 lbs./in.^{2}, because of considerable deformation or earlier dry friction operation. In the long-time test, almost all Al alloys stood up well. A wrought Mg alloy (0.5 Zn, 7.7 Al, bal. Mg) tends to form grooves. The formation of cracks was observed only in conjunction with non-uniform distribution of the load carrying crystals. The wear of the shafts was in all cases negligible. Owing to the sometimes considerable heat expansion, the light metal bearings show some deformation or shrinking. This is one of the most important sources of trouble under actual service conditions. Proper design should prevent the deformation or permit unhindered expansion of the bearing. After stopping the oil supply, temperature increases and run-down times were determined. A Mg alloy containing 2% Mn, 5% Ce, bal. Mg was rapidly destroyed under these conditions. In most cases the shafts exhibited only slight scratches which could easily be removed by polishing, although the dry bearings were sometimes considerably damaged. The dry friction tests are not considered to be conclusive as to emergency conditions since actual service conditions were not closely simulated. 32 illustrations. 8 tables.
EF (10b)

Some Properties of Pure Titanium (Einige Eigenschaften des reinen Titans) W. KROLL. *Metallwirtschaft,* Vol. 18, Jan. 27, 1939, pp. 77-80. Review plus discussion. Gases in Ti exert a considerable influence upon the physical properties. O and N, present in a few thousands of a per cent, will cause Ti to be brittle upon cold working. The hot working characteristics are not affected. The diffusion of these gases into Ti takes place slowly even in the melt so that they can be freely hot worked with little fear of harming the metal through diffusion of N or O. Neither of these 2 gases can be removed by vacuum treatments at 1500° C. H, however, can be removed by vacuum treatments at this temperature. Attempts to deoxidize the melt with C or Th have been unsuccessful. Crucible linings of sintered corundum or crystalline MgO are unsatisfactory for melting Ti, the corundum being reduced by the melting Ti while the MgO decomposes several hundred degrees below the melting point of Ti. CaO linings have proved the most satisfactory for the production of O-free melts, when heating is stopped as soon as the Ti becomes molten. A slight rise in temperature above the melting point will cause the CaO to decompose and give off Ca vapors. Thorium oxide makes a good lining and will not react violently with the molten Ti, though it does contaminate the melt with Th and O. Concerning the effects of alloying on properties, it has been observed that Si decreases only slightly the hot formability but does increase hardness and cold brittleness. A few tenths of a per cent Al or up to 2% Fe are not harmful; the Fe increases the Rockwell C hardness from 20 to 30. Zr alloys readily with Ti, but the alloy is more sensitive to gases than pure Ti. Ta and Cb impart to Ti good rollability and increased corrosion resistance. The corrosion resistance of Ti is similar to that of the 18-8 Cr-Ni steels. The high temperature hardness (up to 550° C.) and the softening of cold rolled Ti are reported. It is suggested that at elevated temperatures additional slip planes are available, leading to better formability. Dilatometric experiments indicate that there is a transformation in pure Ti at about 880° C. GA (10b)

Bronze Worm Gears. J. A. HATCH (McCallum-Hatch Bronze Co.) *Steel,* Vol. 104, Mar. 6, 1939, pp. 69-70, 72. Practical. Experience with bearing bronzes lead to their adoption for worm-gears. Sand-cast 89% Cu-11% Sn gear bronze has a duplex structure. One phase contains more than 20% Sn, forming the hard, load-supporting δ crystals. Others may contain 5-11% Sn, forming softer α crystals. Measurements made on automobile worm-gears that had worked more than 70,000 miles showed that δ crystals stood out in relief 4-6 microns above the α. Rapid cooling produces a dense casting of higher hardness and strength. However, it interferes with formation of the duplex structure, thus lowering the antifriction properties. This structure is not formed on extremely slow cooling. Annealing causes absorption of the δ crystals. By adding a small percentage of Ni, strength and density can be increased, while a duplex structure is formed, regardless of cooling rate. This hard phase is not laminated like δ but is a solid formation, which makes it better supporting. Addition of Pb improves machinability and antifriction properties, aids in "running in," and gives a quieter running unit, but reduces resistance to compression and wear under extreme loads. Amounts up to ½% have no appreciable effect on strength. Amounts of 5-10% are used in bronze designed for soft steel worms and no great loads. High-strength bronzes were developed primarily for strength and resistance to shock, compression and corrosion. They are not so satisfactory as Sn bronzes for worm-gears, as their coefficient of friction is higher, owing to insufficient difference in hardness between the major structural phases of the alloys. More prominent rivals of Ni-Sn bronzes in worm-gear field are Al bronze, Mn bronze, and, to a much lesser degree, Sn bronze. Al-bronze worm-gears have served successfully in light trucks where speed was high and load not great, but they failed in heavy-duty equipment. Mn bronze is never recommended for high-speed worm-gears, but may give long service where motion is slow. Its efficiency is low and it is uneconomical. If a high quality steel worm and approved workmanship are used, the best bronze to use for gears is the one of highest quality showing lowest coefficient of friction and maximum physical properties.
MS (10b)

Creep During Dynamic Loading, and the Determination of Dynamic Creep Strength (Ueber den Kriechvorgang bei dynamischer Belastung und den Begriff der dynamischen Kriechfestigkeit) E. O. BERNHARDT & H. HANEMANN. *Z. Metallkunde,* Vol. 30, Dec. 1938, pp. 401-409. Experimental. Creep experiments were made on soft Pb by superimposing dynamic stresses on static stresses. The results indicated that, as in static creep, the process can be divided into 2 parts: (1) That due to interchange of atomic positions at grain boundaries and during recovery, and (2) that due to translation. The dynamic part of the creep results from the conversion of some of the damping energy into energy of deformation. Measurement of the dependence of creep upon the frequency and amount of dynamic stress confirm the supposition that damping capacity may be taken as a measure of dynamic creep. If the static case is considered as a boundary condition, dynamic creep may be defined as the result of the combined influence of (a) the magnitude of the static load, (b) the amplitude of the dynamic load, and (c) the frequency of the dynamic load. This applies only when the dynamic creep strength does not exceed the fatigue strength. GD (10b)

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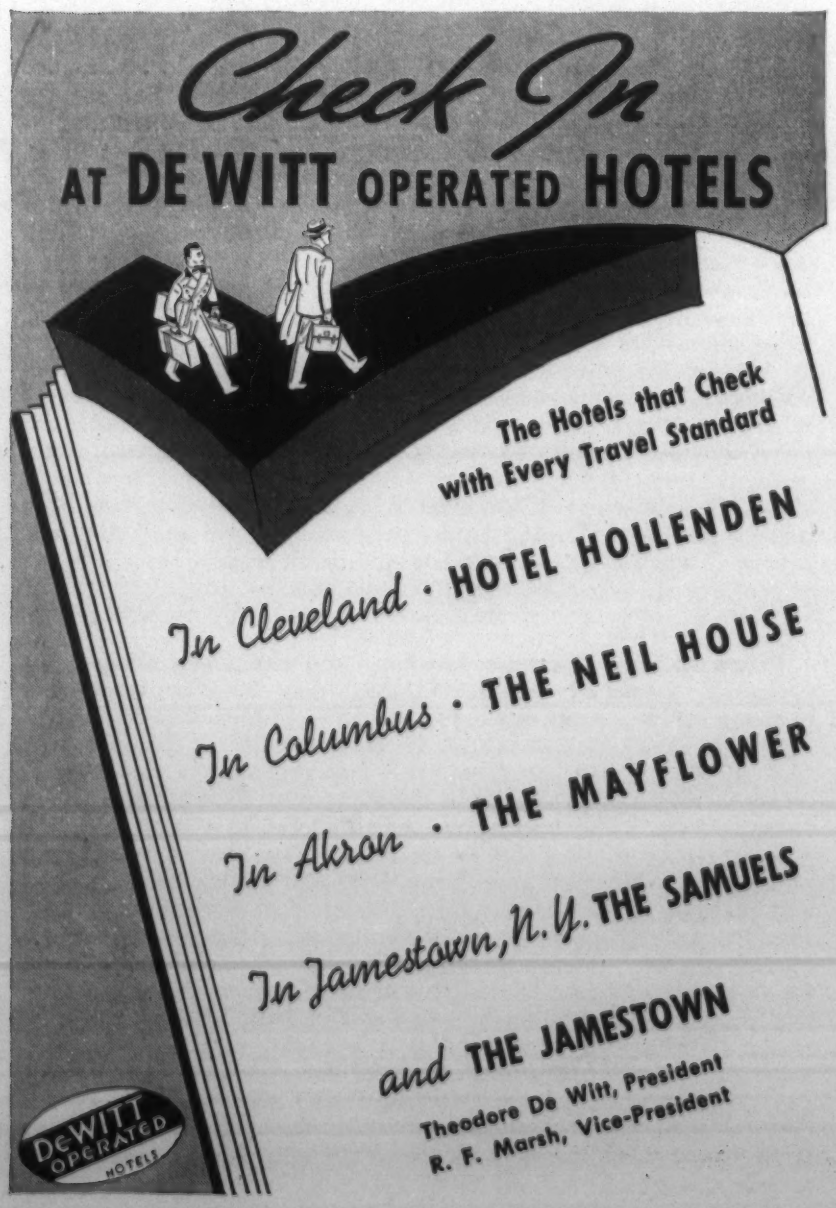
Age-hardening Magnesium Alloys. W. F. CHUBB. *Light Metals,* Vol. 2, Apr. 1939, pp. 136-140. Review. The literature on the Mg-Al system is reviewed. The equilibrium diagram has been fairly well established, although there is still a little doubt concerning the precise limits of the solid solubility of Al in Mg. X-ray investigations have indicated that the limit of solid solubility of 7.5% Al in Mg at room temperature, microscopic examinations indicate much less than this; probably close to 2%. The fact that alloys of 4% Al are slightly age-hardenable bears out this lower solubility limit. While alloys containing about 4% Al are somewhat age-hardenable, it is commercial practice to use alloys of 6-8% Al. Alloys higher in Al have been investigated, but they have been found to be too brittle for most uses. The maximum tensile strength of the 10-11% Al alloy varies from 44,000 lbs./in.^{2} as solution-quenched to 53,000 lbs./in.^{2} as aged 24 hrs. at 150-175° C. The hardness rises from 62 to 95 Brinell. The elongation, however, drops from 9 to 3%. Binary Mg-Al alloys are subject to non-uniform age-hardening, an effect that can be largely avoided through the use of certain ternary alloys. The working of Mg alloys imposes certain conditions of fabrication that must be met for satisfactory results. Very little cold working may be used. Hot rolling at about 300° C. is universal practice; extrusion is often used as a first step in the preparation of billets for further working as it breaks up the Mg-Al eutectic and furthers the dispersion of the microconstituents. Extrusion has a decidedly beneficial effect on the ductility of the final product. There is little data on the high temperature properties of Mg alloys, but it is well known that Al up to about 7% increases the hot tensile strength, at least at 300° C. AUS (10b)

Progress in the Application of Gallium (Fortschritte in der Verwendung des Galliums) E. EINECKE. *Umschau,* Vol. 43, Mar. 12, 1939, pp. 246-248. Review. Gallium (melting point 85.6° F.) is used for thermometers. Quartz glass capillary tubes, after being completely filled with the metal at the desired maximum temperature are closed by melting. In this way vacuum thermometers are created that are applicable at higher temperatures and are more accurate than Hg thermometers. Up to 1000° C., the vapor pressure of Ga is negligible. This metal can be undercooled below 0° C. so that temperature measurements below the melting point are possible. A Ga thermometer might replace in many cases the costly thermo-electric measurement. Careful cleaning of the Ga is essential for satisfactory operation. The lack of a completely lustrous surface makes the metal adhere to the glass or quartz surface. Difficulties encountered were: Contamination of the capillaries and separation of the thread. These phenomena are caused by superficial oxidation which, it is said, can be prevented by the addition of gallium-(III)-chloride. An additional filling with H_2 as reducing agent, or hydrochloric gas is suggested. Instead of the pure metal, liquid alloys such as 30% Ga, 10% In, 60% Sn have been proposed; no comments on experience are available. The low melting point makes Ga well suited for electric fuses, etc. Owing to its relatively high boiling point (3750° F.), it is used as liquid seal for elevated temperatures. Its use is suggested in metal vapor lamps. Optical mirrors can be made with Ga. Owing to their selective reflection, their application for astronomic purposes is suggested. The metal or its salts have recently been used for electron tubes. Ga has an electrolytic blocking and rectifying effect similar to that of Al. In the medical and dental field, Ga can replace Hg because it is non-poisonous, *e.g.* for tooth fillings as a Ga-Sn-Bi alloy. This alloy is silver white and melts at 112° C. Its volume is stable, and the alloy has pronounced adhesion. It is corrosion-resisting as long as it does not come in galvanic contact with nobler elements. Ga salts are used in pharmaceutical products. It is hinted that fertilizers containing additions of Ga and Ge have shown better results. Future possibilities are mentioned, such as Ga as alloying element and Ga as catalyst. The lack of scientific research on Ga and its properties is emphasized. RPS (10b)



10c. Effect of Temperature

H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

New Developments in Steels for Oil Refinery Service. MARTIN FLEISHMANN (Timken Roller Bearing Co.) *Oil & Gas J.,* Vol. 37, Mar. 30, 1939, pp. 94, 96, 129, 132, 136, 138. The range of Cr steels of from 5 to 10% Cr with 0.5-2% Si and up to 1.1% Mo was investigated and detailed data given. The stress-rupture test is considered to be of most value in the evaluation of steels for use in cracking still tubes because it not only provides a definite basis for design but also yields valuable information with respect to the influence of time, temperature and stress on the surface and structural stability and the hot ductility of the steel. Mo improves the strength and resistance to temper embrittlement. This improvement increases up to 2% Mo, above which it is not so effective. V is beneficial in combination with Cr in imparting resistance against H penetration under high temperature and pressure conditions. Si or Si + Al increases the corrosion resistance of these steels, and also their oxidation resistance. Considerable data are given in the form of curves. VVK (10c)

Embrittlement of Heat Resisting Steel at Elevated Temperatures (Versprödung warmfester Stähle bei höheren Temperaturen) R. SCHERER & H. KIESSLER. *Arch. Eisenhüttenw.,* Vol. 12, Feb. 1939, pp. 381-385. Review plus original research. A review of the literature indicated that heat resisting steels containing Ni were prone to show embrittlement after prolonged heating to about 450° C. Steels without Ni were less prone to such embrittlement, and Cr-Mo steels were particularly resistant. This was confirmed by the authors' experiments. The embrittlement was attributed to local stress concentrations and hardening at the grain boundaries, and was considered to be similar to temper brittleness rather than to aging after cold working. The brittleness resulting from heating at about 450° C. could be eliminated by heating above this temperature to about 500°-600° C. SE (10c)

High-temperature Design. E. A. DAVIS (Westinghouse Elec. & Mfg. Co.) *Product Eng.,* Vol. 10, Mar. 1939, pp. 104-106. Review. The manner in which the allowable total deformation in a given time for members operating in high temperature can be determined, and how creep curves and aging characteristics of the material to be selected are taken into consideration, are described in detail. Similarity of physical properties of 2 materials at room temperature is no guarantee of such similarity at high temperatures. At present, it is usually necessary to proceed empirically in designing for high temperature service; the engineer must run numerous creep tests on the materials in question under conditions simulating as closely as possible those expected in service. Long-time creep tests, relaxation tests and constant strain-rate tests are described. Methods and formulas for extrapolation and for calculating deformation are discussed. Ha (10c)

11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Corrosion of Aircraft Materials. A. J. SIDERY & J. W. W. WILLSTROP. *Metal Ind., London,* Vol. 54, Feb. 10, 1939, pp. 179-181; Feb. 17, 1939, pp. 208-210. Review. The necessity of careful temperature control during solution heat treatment of duralumin, and the beneficial influence of a rapid cooling rate after such heat treatment on the corrosion resistance is now widely appreciated. Wrought Al alloys requiring artificial aging are usually found susceptible to intercrystalline corrosion. Quenching in cold water from solution heat treatment temperature results in slightly better tensile strength and improved corrosion resistance, than does quenching into boiling water, even when finally aged at elevated temperatures. The application to fully heat treated and aged duralumin of processes that require reheating, may cause serious reduction in its intrinsic corrosion resistance. Application of such processes as baking in enameling should not exceed 125° C. Serious consequences from the point of view of resistance to corrosion have followed the application of cold forming operations to certain finally heat treated and aged Al-alloys. This can be considerably reduced by carrying out all forming operations on annealed material and then applying the requisite heat treatment. Normally, heat treated and aged duralumin shows comparatively high resistance to failure under stress/corrosion conditions. Corrosion by leaded fuels is lowered by the presence of inhibitor cartridges. The less soluble inhibitor salts are preferable for this purpose, owing to their longer life. The use of organics for temporary protection has been in use for many years. The use of resin-hardened lanolin shows promise. The weight of pigmented varnish coatings is of the order of 2 oz./yd.^{2}, whereas resin-hardened lanolin is 0.6 oz./yd.^{2} On large flying boats, pigmented varnish coatings may exceed 400 lbs. The film of resin-hardened lanolin is readily removed and reconditioned at will. Corrosion tends to become concentrated at inaccessible areas; therefore, a joining compound should be used in the joints. An alloy of 45 Ni, 23 Zn and 30 Cu offers useful application for riveting stainless steel. The provision of a satisfactory rivet material for Mg-rich alloys still presents a difficult problem from the corrosion standpoint. Corrosion of radiators from the zinc chloride flux residue can be largely overcome by using very weak acid (1% HCl) for flushing instead of plain water. A good alternate flux (instead of zinc chloride) is 10% phosphoric acid in alcohol. Ethylene glycol in the cooling system introduces further corrosion problems. At 130° C. it affects most metals and also forms a sludge that impedes circulation. Ordinary solder is most subject to this attack; of the other solders, the Ag-Pb alloys are most promising but offer more difficulty in "tinning", and the higher melting points make repairing more difficult. Cupro-nickel is more resistant to glycol than is brass. Anodic treatment of Al alloys offers little protection against glycol attack. Chromates cannot be used as inhibitors in glycol. Apparently 2% of an inhibitor solution composed of 10 parts of triethanolamine with 3 parts of phosphoric acid added to glycol offers the most promise. RWB (11)

Corrosion Protection of Refinery Equipment. J. A. JAMISON. *Proc. Am. Petroleum Inst.,* Vol. 19 (III), 1938, pp. 46-89. This paper is the result of a field survey of corrosion problems of refinery equipment in the major refining areas of the U. S., secured under the sponsorship of the Committee on Corrosion of Refinery Equipment. 33 pages of case histories are given. These are summarized as follows: *Crude Distillation.* Practically all furnace tubes used in crude distillation units are of low-C steel. Where trouble is encountered, 4-6% Cr, 0.5% Mo is used. Corrosion in crude distillation bubble towers, operating either under vacuum or at low pressure, is localized to the shell at: (1) The flash zone opposite the vapor inlet; or (2) the top of the tower in the area of the reflux connection. The intermediate parts of the tower seldom suffer any noticeable attack. Overhead condensing equipment consists of coil-in-box, total condensers, usually shell-and-tube type, and partial condensers. Ammonia is the customary neutralizer employed to protect the vapor side of the coil, a pH value of about 8 in the steam condensate being maintained when iron is used and 6.5-7, when brass or admiralty tubes are used. In condensers, exchanges and coolers, corrosion almost always occurs from the water side. Salt removal from crude is discussed. *Cracking and Viscosity Breaking.* Case histories of corrosion of furnace tubes are reviewed. Two general methods are used to reduce corrosion in cracking furnace tubes: (1) The addition of lime to the furnace charge to neutralize $_2S$, and (2) the substitution of alloy tubes for C steel tubes. Most of the data collected on alloy tubes deal with the 4-6 Cr, 0.5% Mo and to a lesser degree, 18-8 Cr-Ni alloy. 18-8 is never corroded and, aside from a few cases when it was first introduced, does not fail by sudden rupturing. Cracking vessels are generally protected by gannister lining; 11-13% Cr is slowly being adopted by an increasing number of plants. Al metal spray is used, but not so much as formerly due to difficulties of insuring an adherent coating. *Gasoline Recovery and Stabilization Plants.* Corrosion is ordinarily of small magnitude. *Re-run Units.* The corrosive agent in distillation units that are employed to re-run pressure distillate that previously has been stabilized, acid-treated and neutralized, is chiefly sulphur dioxide. Corrosion manifests itself particularly in the lower temperature ranges, where the vapor and steam are condensed, and in the top of the bubble tower. Both aqueous caustic and, to a much greater extent, anhydrous ammonia, are used successfully to combat corrosion. VVK (11)

Corrosion and Scale Formation in the Cooling Water System of Combustion Engines (Korrosion und Wassersteinbildung im Kühlwasser Kreislaus von Verbrennungsmotoren) WALTER RIEDEL. *Automobiltech. Z.,* Vol. 42, Feb. 15, 1939, pp. 57-61. Practical. The cooling system consists of various metals and alloys. The cooling agent contains harmful ingredients, O is dissolved by the water to saturation, and the temperature changes constantly; corrosion proceeds at a high rate. The resistance of the metals and their alloys to chemical attack is indicated by their position in the "electromotive series." Whereas pure metals have a characteristic potential, the values for alloys change with their composition; the value also changes, sometimes drastically, with the electrolyte used. Owing to this effect, Fe is attacked much slower in an alkaline electrolyte than in neutral or acid. Purity is an important factor. Corrosion progress is not always linear with time. Some metals become covered with a dense oxide film, preventing further progress. In order to prevent corrosion, a certain current density is required. The effect of protective coats (plating, galvanizing, etc.) is based on this fact. The protection of entire metal groups is possible by protective ingredients that change the electrolyte so that the system is shifted to a position in the electromotive series where attack does not occur. Various additions to cooling water that have this effect and that prevent sediment formation are discussed. Sodium silicate causes alkaline reaction and reduces corrosion. CrO_3 prevents sedimentation by forming metal compounds and free harmless acids. Deposition of scale is prevented by colloidal graphite. Mineral oil is useful but forms deposits after a while. $K_2Cr_2O_7$ binds the water hardener to soluble salts. RPS (11)

View Points Concerning a Commonly Used Method of Testing Corrosion (Synpunkter paa en ofta anvaend korrosionprovingsmetod) SVEN BRENNERT. *Tek. Tid.,* Vol. 69, Jan. 14, 1939, (Section *Kemi*) pp. 5-8. A discussion of the various precautions that must be taken in accelerated corrosion tests. Tests include suspension of samples in a stationary solution, and in solution through which N or air is bubbled; intermittent immersion; continuous immersion; spray; and accelerated electrolytic tests. A method should be selected that resembles actual conditions as closely as possible. Tests should always be run in duplicate. Dimensions of samples and containers should be the same in all comparative tests. The amount of solution used should never be less than 10 cc. per cm.^{2} of surface. The samples should always be made sufficiently large, and the corrosion process should never be interrupted until completed. BHS (11)

The Value of Soil-survey Methods. J. M. PEARSON (Sun Pipe Line Co.) *Proc. Am. Petroleum Inst.,* Vol. 19 (IV) 1938, pp. 18-24. *Oil & Gas J.,* Vol. 37, Nov. 18, 1938, pp. 100-102, 128. Soil-survey methods are valuable to pipe-line technologists because their use may lead to: (1) A reduction of long-time over-all operating costs; (2) a reduction of the rate of physical depreciation, and an increase in salvage value of buried lines; (3) a reduction of hazards entailing large liabilities; (4) a satisfaction of intellectual curiosity. The mechanism of corrosion is discussed as applying to acid, intermediate and alkaline soils. Various formulas are critically reviewed and the following "rational procedure to follow in soil testing" offered. (1) Map the soils traversed according to type as determined by texture (coarse, fine, colloidal, etc.), aeration (wet or dry, access to air, etc.), water (pH, average moisture content, variability, etc.), total acidity, dissolved salts (especially Cl, SO_4, NO_3, CO_3), resistivity. (2) Obtain numerical data from other pipe lines in these or similar soils on their corrosion experience. From this, and soil samples, one can: (a) Determine "soil constants" from experience of other lines; (b) correlate "soil constants" with soil test data (from this a usable correlation of some soil property with experienced corrosion might be found); (c) subject any proposed criterion of soil corrosiveness to the cut-and-try tests above to correlate the predictions of the method with experience. (3) Establish criteria that may be used in the field to locate coatings with the best probability of success. 23 references. VVK (11)

The Use of Rust-hole Records to Study Pipe Service. WALTER F. ROGERS (Gulf Oil Corp.) *Proc. Am. Petroleum Inst.,* Vol. 19 (IV) 1938, pp. 25-35. Results of a study of 4,000 miles of pipe line ranging in diameter from 4 in. to 12 in., laid bare and up to 35 years of age. A relationship exists for pipe lines between the cumulative number of rust-holes and time. The relation is expressed by the exponential equation $R = bT^n$, where R = cumulative rust-holes, T = time in year, b = the intercept of the curve on the R axis, which is the value of R when T is one yr., and n = slope of the curve. Pipe lines of short length may have two or more values of n during the first 10-15 yrs. of their history. The longer the pipe line, the fewer are the values of n. The value of reconditioning to a pipe line may be determined by plotting the relation of cumulative rust-holes vs. time for the line. It is shown for the pipe lines studied that "hot-spot" reconditioning is more economical than "long-line" reconditioning. The cumulative rust-hole vs. time curves for 6 in. and 8 in. pipe with a minimum age of 15 years is used to calculate the value of pipe-wall thickness in governing the occurrence of rust-holes. The data show that pipe weight should be governed entirely by the pressure to be used, and no wall thickness should be added for soil-corrosion attack. Soil corrosion best can be taken care of by pipe coating and cathodic protection. VVK (11)

Standard Bronzes and Sulphuric Acid (Normbronzen und Schwefelsäure) TH. EDER & F. KENDÖL. *Korrosion u. Metallschutz,* Vol. 15, Mar. 1939, pp. 85-86. Practical. The chemical resistance of bronzes is determined by their Cu content; increasing Sn content reduces the resistance, while small additions of Zn and Pb have practically no effect. Deoxidation of the phosphor bronzes retards corrosion only slightly. The attack increases largely with the acid concentration; even small amounts of H_2O have a strong retarding effect; acid of 66° Bé corrodes bronzes several times more rapidly than acid of 60° Bé. A determining effect on the corrosion is exerted by access of O. Hot, diluted H_2SO_4 in the absence of contact with air corrodes bronzes only slightly, but with access of air, even cold diluted H_2SO_4 has a strong corrosive effect. Corrosion velocity increases largely with temperature. Ha (11)

Some Notes on Ship Corrosion and Paint. H. E. SKINNER. *Inst. Naval Architects,* Adv. Copy, 1939, 9 pp. Experimental. A special case of rapid pitting in ship plates is analyzed to determine the cause; the possible agent is static electricity. Evidence is given of the similarity in attack on steel electrodes immersed in sea water with an electric current flowing; specimens coated with the usual protective paints or galvanized, when similarly treated, show the weakness of such protection against electrical action. Evidence is also given that static electricity can be present in ships as the result of an experiment performed during some ship trials; if rapid pitting is due to electrical action, protective paints are of little use in arresting it, and a paint resistant to electrical attack would be a more effective protection against corrosion than those at present in use. JWD (11)

Wear and Abrasion Resistant Surfaces. *Product Eng.,* Vol. 10, Apr. 1939, pp. 162-165. Practical. A very useful and comprehensive compilation of the various types of surface finish, hard-facing, hardening by heat-treatment and of the metals and materials to which the respective surface treatment can be applied to obtain the best possible abrasion and wear resistance for a given purpose. Ha (11)

The Present Status of Knowledge of Caustic Embrittlement of Boiler Plates (Gegenwärtiger Stand der Kenntnisse über Laugensprödigkeit von Kesselblechen) G. T. ATHAVALE. *Korrosion u. Metallschutz,* Vol. 15, Mar. 1939, pp. 73-81. Review. The causes of the intercrystalline corrosion that occur with caustic embrittlement, and the means at present used to prevent it by the use of alloy steels are discussed exhaustively. In order to produce caustic embrittlement, the simultaneous effect of mechanical tensile stress and alkaline liquids is necessary. When making a boiler local stresses, as well as interior stresses from cold-working, always occur. It does not seem certain that these stresses have to be above the flow limit of the material to produce caustic embrittlement. The stresses sever the grains and thus facilitate access of the corrosive agent to the grain boundaries. Absorption of H is considered by some authors to be a cause of caustic brittleness, for it is known to reduce the strength of the steel and to cause harmful reactions with the impurities in the steel. H can originate when highly concentrated alkali (present in the boiler seams) reacts with the steel. High N-content steels have a strong tendency to become embrittled by cold-working and aging, through intercrystalline precipitation. 98 references. Ha (11)

The Corrosion of Pure Lead and Lead-rich Alloys (Die Korrosion von Reinblei und niedrig legiertem Blei) O. HECKLER & H. HANEMANN. *Z. Metallkunde,* Vol. 30, Dec. 1938, pp. 410-415. Experimental. Weight loss measurements were made with 99.997% Pb and its alloys with 0.005-0.16% of Cu, Ni, Ag, Bi, Te, Sn, Sb, Cd, Zn, As, Ca and Se. Owing to the formation of protective films, corrosion in concentrated H_2SO_4 and in tap water is low at room temperature and nearly independent of alloy content. Attack by distilled water is relatively rapid and is strongest with Pb-Bi alloys. Solution in dilute H_2SO_4 is rapid and accelerated by addition of more noble elements with a low H overvoltage, but it is retarded by Bi. In hot H_2SO_4, a marked distinction can be made between electrochemical and chemical corrosion. The former occurs when the Pb is in contact with a conducting body that has a low solubility in the acid and a high H overvoltage, resulting in the formation of a partially protective layer of $PbSO_4$ in the form of anglesite. In the absence of such cathode areas, chemical corrosion produces white, non-adherent $PbSO_4$, which affords no protection; such action is especially strong in the presence of Bi. GD (11)

Interior Corrosion and Interior Protection of Steel Gas Pipes (Innenkorrosion und Innenschutz stählerner Gasrohrleitungen) A. MATTING & G. GOOS. *Korrosion u. Metallschutz,* Vol. 15, Mar. 1939, pp. 82-85. Research. The corrosive effect of city gas on the gas pipes was investigated by examination of the corrosion products. Humid gases have a greater corrosive effect than dry gases, and the rate of corrosion increases with increasing temperature. Hydrocyanic acid is more corrosive than CO_2. Heavy hydrocarbons do *not* introduce (as is usually assumed) a corrosion-retarding effect by forming a protective oil film. Crude, rolled steel pipes are more rapidly attacked than wrought iron and cast iron pipes. The contents of H_2O, O_2, HCN and CO_2 should be as low as possible in the gas. As means of protection, burnt-in coats of paint are preferable to paints applied cold. The same paint behaves differently at different places, owing to varying amounts of water vapor and heavy hydrocarbons. All bituminous coats become liquefied under the effect of city gas. Sheets with chemically treated surface have shown good corrosion resistance, although the tests are unfinished. 16 references. Ha (11)

Corrosion in Partially Dry Steam-generating Tubes. F. G. STRAUB & E. E. NELSON. *Mech. Eng.,* Vol. 61, Mar. 1939, pp. 192-202. Review. The phenomenon of preferential corrosion of partially dry areas in steam-generating boiler tubes is explained. A connection seems to exist between metal temperature, composition of the water, gas generated (H_2) and the amount of corrosion. If the metal temperature is below 750° F., sodium hydroxide seems to be the active constituent in the boiler water causing the corrosion. In this case, corrosion may be controlled by modifying the boiler water by reducing the free alkalinity to zero and by adding other salts as sulphate, silicate, etc. If the metal temperature is above 750° F., corrosion occurs in the absence of sodium hydroxide, and chemical treatments effective at lower temperature are no longer protective. The temperature, in such case, should be controlled so that in potentially dry areas it cannot exceed 750° F. Ha (11)

Intercrystalline Corrosion of Soft Iron in Ammonium Nitrate Solution (Beitrag zur Kenntnis der interkristallinen Korrosion von Weicheisen in Ammoniumnitratlösung) M. SMIALOWSKI. *Korrosion u. Metallschutz,* Vol. 15, Mar. 1939, pp. 81-82. Research. Intercrystalline corrosion of soft Fe takes place in ammonium nitrate solution even without presence of mechanical stresses. Coarse-grained samples which had been stress-relieved at 850° C. became, after 8 hr. exposure to boiling ammonium nitrate solution, so brittle that they disintegrated into single grains when bent. Ha (11)

12 General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

Applications of Supersonic Waves. *Metallurgist* (Suppl. *Engineer*) Dec. 1938, pp. 177-179. Review. Supersonic waves are waves with frequencies lying above those in the range of audible sound. The most important method of producing supersonic waves is that of converting electrical vibrations into mechanical vibrations, frequencies up to about 50 kHz being produced by a magneto-striction sound producer and 200 million Hz by a piezo-electrical sound producer. They have been used for destroying labile equilibria, starting chemical reactions and for studying their electrochemical and photochemical effects. Metallurgically, interesting results have been obtained. Claims have been made that the physical properties of steel, especially the strength, have been improved by high-frequency vibration, as well as a considerable reduction in the time required for nitriding and in depth of penetration of the N. Molten Zn, when allowed to solidify under the action of supersonic waves of 650-4500 kHz, showed a finer grain of more needle-like structure than when solidified without the wave treatment. An increased fineness of grain has been found with silumin and duralumin exposed to the waves and a corresponding change in mechanical properties. Supersonic waves have been used in testing materials. Iron and steel specimens allow supersonic waves to pass through them very easily. It is possible to pass the waves without difficulty through a depth of many meters of steel, provided the metal is free from defects. Cracks or blow-holes reflect and also absorb the waves. This can be used to locate failures in a material, which application is at present in an early stage of development. Other applications are given. VVK (12)

The **Manufacture of Duralumin.** G. SACHS. *Metal Ind., London,* Vol. 54, Mar. 3, 1939, pp. 263-266; Mar. 10, 1939, pp. 289-292. General. Most duralumin used today is of practically the same composition as the original alloys developed 25 yrs. ago, although modifications have been developed for special purposes. The special type alloys have practically the same mechanical properties, their strength and hardness being about 10% higher, with a somewhat lower ductility. All the special alloys contain about 2% Mg plus Mn; their room temperature aging is slower and can be controlled better. A forging alloy of higher Si, without Mg, is extensively used. For higher strengths small percentages of Sn are added. Roll-plated material like Alclad are regarded as somewhat more ductile than ordinary dural and less susceptible to intercrystalline corrosion. In making Al alloys, the master alloys should be melted under a flux, stirred thoroughly, and allowed to set before casting. Scrap should be refined before adding to the melt. CO_2 is sometimes used as a special atmosphere. The favored process for "breaking down" dural is extrusion. Bars extruded at low temperatures are inferior to bars extruded at high temperatures. A uniform, fine-grained structure (instead of the usual fine grain core and coarse-grained surface) is obtained if the extruded bar is given a 10% cold reduction before the final heat treatment. Considering everything, a large cast ingot, usually produces better material than a small. Much consideration has been given to the development of special equipment for uniform heating of the extrusion container. The basic rule for casting Al and its alloys is to keep the liquid metal continuously flowing from the ladle to the mould through a "hose" of aluminum oxide. The slightest overheating will exaggerate the tendency for Cu-rich segregations to occur. To overcome this, several casting methods, based on regulation of solidification so that only a horizontal layer of predetermined thickness is liquid at any one time, have been developed. Duralumin is one of the most difficult alloys to manufacture successfully. Dural shapes cannot be used in the "as heat treated" state without any additional cold deformation, as they warp badly on quenching; they must be straightened, usually in the advanced stages of age hardening. Although forgings are generally considered superior to castings, it is difficult to produce uniform bulky forgings and very good results are obtained with cast parts for high strength application. Forming operations are usually carried out with soft annealed material immediately after quenching; to avoid recrystallization the amount of deformation in straightening and forming has to be carefully regulated. 0.4% Mn lowers the tendency to recrystallize. Annealing of Dural is often carried out at too high a temperature. Normally Dural can be heated to 520° C. without harmful effect, but local Cu segregations melt at 505° C. and higher temperatures cause embrittlement. Therefore an actual temperature of 505° C. should be the maximum temperature for heat-treating high strength Dural. Dark surface spots are the result of non-uniform cooling. Air quenching reduces warping. The speed of cooling has to be sufficiently high to prevent precipitation. Cooling in compressed air to 300° C. followed by quenching in cold water has been found very satisfactory. The usual aging at room temperature for 5 days is not a definite process and control of mechanical properties of material thus aged is difficult. The author advocates aging at 35° ± 5° C. for at least 6 hrs. In this manner a more uniform product can be obtained, and the production time is greatly reduced. RWB (12)

Annual Report of the Non-metals Division, Fiscal Year 1938. OLIVER C. RALSTON & OTHERS. *U. S. Bur. Mines Rept. of Investigations* 3427, Dec. 1938, 38 pp. Results obtained during 1938 are summarized, including utilization of opaline SiO_2 for production of SiO_2 brick; properties of olivine refractories from Cypress Island, Wash.; use of olivine as foundry sand; quantitative spectroscopy; cracking of steel by boiler water; float-and-sink fractionation of the low-P ferruginous sandstone of the Birmingham district; and electrostatic concentration of minerals. By careful dehydration of opaline SiO_2, brick could be produced more easily than from quartzite. Lower initial densities of the dehydrated material would result in volume shrinkage rather than expansion during inversion. Prefiring would be unnecessary for effecting volume stability. Intercrystalline cracks can be produced in steel by many solutions containing both a corrosive and a partly protective agent. The combined action of selective corrosion, grain boundary stress, and bursting forces exerted by the corrosion products would rapidly propagate the intercrystalline crack. At least 4 factors must act simultaneously to produce intercrystalline cracks in an operating boiler: (1) A boiler water that, when concentrated, will produce intercrystalline cracking, (2) high stress in the metal, (3) very slow leakage in certain areas that will allow formation of film of concentrated solution, and (4) contact of film of concentrated solution with highly stressed boiler metal. AHE (12)

Vector Diagrams of Complex Alloys. *Metallurgist* (Suppl. *Engineer)* Feb. 1939, pp. 12-13. Extended abstract. Carl Benedicks has recently *(Comptes Rendus,* Vol. 207, Dec. 27, 1938, p. 1398) suggested a method of representing complex compositions such as those of the light alloys. A semi-circular diagram is drawn containing a number of radii in easily distinguishable directions; for example, by dividing the semi-circle into 8 equal parts, which gives 9 different radii. Divisions along the length of a radius constitute a scale of composition. Each radius refers to one of the constituent elements—Si, Cu, Zn, Mg, Mn, Fe and Ni. Any vector parallel to a given radius indicates the identity and amount of a constituent in the same way as a length along the radius itself. VVK (12)

Selenium and Tellurium Production Increasing Slowly. *Chem. Eng. Mining Rev.,* Vol. 31, Jan. 10, 1939, pp. 166-167. Production figures are given for the U. S. A. and Canada, and show that the demand for these metals is increasing very slowly. Copper and Kalgoorlie telluride ores are sources of supply in Australia. The flowsheet is shown for recovery of Se and Te at the Canadian Copper Refineries, Ltd., at Montreal, and uses for the metals. **World Position of Magnesium and Aluminum.** JAMES RUBINFIELD. *Ibid.,* pp. 168-169. Japan has become an important world producer of Mg and Al. WHB (12)

Review of Iron and Steel Literature for 1938. E. H. MCCLELLAND (Carnegie Library of Pittsburgh) *Blast Furnace Steel Plant,* Vol. 27, Jan. 1939, pp. 93, 96-97, 115-117, 121. *Heat Treating Forging,* Vol. 25, Feb. 1939, pp. 73-79, 83. List of separately published books and pamphlets relating to the Fe and steel industry. Includes a few published late in 1937. Reprints, with additions, by the Carnegie Library of Pittsburgh may be obtained for 5 cents, post paid. MS (12)

books

Magnesium as a Structural Material *(Werkstoff Magnesium) 2nd Ed.*

VDI-Verlag, Berlin, 1939. Cloth, 6 x 8¼ in., 164 pages. Price 8 RM.

The first edition, published a little over a year ago has been exhausted, and the book has been rewritten by the ten authors of separate sections. The properties of the wrought magnesium alloys covered by German specifications are given in detail. Sand, permanent mold and die castings, hot working by forging, extrusion, etc., machining, protection against corrosion and the environments in which it resists corrosion are discussed. Many commercial applications are illustrated and the suitability of magnesium explained.

While the booklet is a type of propaganda and may put the best foot far forward, it is evident that industrial utilization of magnesium has advanced far enough in Germany to justify the title. It has arrived as a material of construction.—H. W. GILLETT.

Aluminum *(Aluminium)*

Gmelins Handbuch der anorganischen Chemie, 8th Ed. (System No. 35, Aluminum) Part A, Section 6, Aluminum Alloys.

Verlag Chemie, Berlin, 1939. Paper, 7 x 10 in., 223 pages. Price 27.75 RM.

The various parts of the Gmelin handbook appear whenever a section is completed. This one on aluminum alloys covers Al-Mn, Al-Ni, Al-Co, Al-Ag, Al-Au, and Al-Pt (Pt group) as well as more complex alloys based on these binaries. The literature references are extraordinarily complete, and are brought up to September, 1938.

This section is metallurgical in nature. Despite the title of the handbook, metallurgists and physicists will use the handbook for reference as much as will the chemists.—H. W. GILLETT.

Failures of Locomotive Parts *L. H. Williams*

Published by the author, Y. M. C. A. Building, Pt. St. Charles, Montreal, Quebec, 1938. Leatherette, 8½ x 11 in., 35 pages. Price $5.00.

Reprints of a series of articles by a test engineer of the Canadian National Railways that appeared in *Railway Mechanical Engineer*, bound in limp leatherette. Cases of fatigue failures predominate in these post mortems, which are discussed from the point of view of how to prevent their recurrence.

While the specific cases discussed are of particular interest to railway metallurgical engineers, they are useful to all as practical examples of troubles resulting from stress concentration.—H. W. GILLETT.

Forging Handbook

Waldemar Naujoks & Donald Fabel

American Society for Metals, Cleveland, 1939. Cloth, 6½ x 9¼ in., 630 pages. Price $7.50.

This handbook on forging is a welcome addition to the literature on this subject. There have been, and are frequently, articles and technical papers on various forging topics, but comprehensive discussions in book form are few. The authors have, therefore, fulfilled a decided need. As the authors declare in their preface, "The art of forging is one of the oldest of the mechanical arts, yet less has been written on this subject than on any of the other phases of metal working."

Besides the information that the authors themselves have, one of whom has had a wide experience as the chief engineer of a leading drop forging company, data for the treatise have been drawn from 83 other companies and organizations.

There are 20 sections and chapters, dealing with almost every phase of the forging industry, including forge plant equipment, dies and tools, forging practice, heat treatment, cleaning, testing and inspection, plant design and maintenance, materials handling, furnaces and furnace design, forging materials, costs and so on. There is a section on forging definitions as well as one containing mathematical tables and other data. Most of the sections are fully illustrated, there being 426 half-tones and drawings.

Not only are ferrous materials, including stainless steels, but also non-ferrous discussed.

Acknowledgment is gratefully credited by the authors for the help of the unpublished Drop Forging Handbook of the American Drop Forging Institute and for the generous criticism of a number of leading men in the forging industry.—E. F. CONE.

Welded Steel Construction

Robert S. Hale

Pitman Publishing Corp., New York, 1938. Cloth, 5¾ x 8¾ in., 170 pages. Price $3.00.

This book is a concise tabulation of welding methods, design, and cost estimation of welded structural steel buildings, bridges, etc.

It is written from the civil engineers' and contractors' point of view, and includes building code provisions and many tables for the designer. Everything is on the basis of ordinary weldable structural steel. No attention is paid to an alloy or high carbon steel in which stress relief treatment might be required, testing and inspection of welds is mentioned as necessary but scarcely an inkling is given as to how to carry out such inspection. It is recognized that coated and bare rods give different results, and the reader is advised to consult the recommendations of reputable manufacturers.

An unusual amount of information is given on the costs entering into welded construction. The book is likely to be of real use to contractors and estimators, of some value to civil engineers on matters of design, but of no utility in respect to any of the metallurgical problems that arise in welding.—H. W. GILLETT.

Metallographic Etching *(Ätzheft) 2nd Ed.*

A. Schrader

Gebrüder Borntraeger, Berlin, 1939. Cardboard, 5¾ x 8¾ in., 24 pages. Price 1.60 RM.

Selected etching media and techniques for steel, cast iron, stainless steels, Al, Pb, Cu, Mg, M, Ag, W, Zn, Sn and their alloys are tabulated. Polishing, mounting and proper etching times and temperatures for bringing out individual constituents are discussed in relation to a few special cases.

Half of the references cited have appeared in the five years since the first edition. Some of the etchants formerly recommended have been replaced by newer ones which the author's experience has found superior. Since the author is the Angelica Schrader of the "Atlas Metallographicus," the selections may be taken as authoritative.—H. W. GILLETT.

Foundry Work

W. C. Stimpson & B. L. Gray
Revised by J. Grennan

American Technical Society, Chicago, 1939. Cloth, 5¾ x 8½ in., 216 pages. Price $2.00.

Not very often will the foundryman or would-be foundryman encounter so thoroughly practical a volume as this. It is written in his language and with evident recognition of the fact that few metallurgical unit operations are as dependent on "kinks" for their successful performance as is foundry work. The great practical appeal of this book, a revision of an earlier volume, results directly from the detailed attention given to so many of these kinks.

The book is divided about equally into two parts—the first on molding practice, and the second on casting operations. The first part covers types of molds, molding materials, tools and processes, typical molding problems, molding machines, pattern mounts, open sand molding, loam molding and core making; the second section features foundry materials, fuels, melting, handling and cleaning equipment, foundry products and the general processing for each, specifications and heat treatment. The first part of the book, because it treats of operations that are practically the same whatever the metal being cast, is much more detailed in treatment than is the second, which is forced to cover the vagaries of melting and casting about 10 types of metal in some 60 pages.

Although the material is up-to-date, the discussions of the metallurgy and of the engineering properties of the various cast metals is very brief. The book is thus most useful to those interested in the elementary details of *making* castings, and particularly in the equipment used therefor.

Reading this book leaves one with a very keen awareness of the extent to which sound engineering has become a factor in foundry operations, and to which responsibility for successful performance has been shifted to men with engineering knowledge. Thus, in speaking of sand control, the authors say: "In production foundries, the old time skilled molder has disappeared. The molder now uses a molding machine and may make only a part of a mold. He may learn what he is required to know about molding in a few days and he has no control over the sand he uses. Where continuous molding and pouring are carried on in a foundry and machinery is used for mixing the sand, *someone must be responsible for sand control.*" Today, that "someone" is invariably an engineer, and, in the foundry, sand is only one of the many things he controls.—FRED P. PETERS.

Alloy Cast Irons

American Foundrymen's Assoc., Chicago, 1939. Cloth, 6 x 9 in., 257 pages. Price $3.00.

This handbook is the product of 4 years of cooperative effort by some 50 individuals, representing users and producers of cast iron as well as producers of alloying elements. A maximum of useful information with a minimum of ballyhoo has resulted from these joint efforts. As a matter of interest, some information is included on Bi and Co, and the effects of altering the composition as to Mn, Si, and P are of course discussed, but chief attention is paid to the effects of Cu, Mo, Ni, Ti, and V.

The mechanical and physical properties, discussed from the point of view of the way they are affected by alloying, are: Hardness, transverse, tensile, deflection, compressive, shear, torsional, fatigue, and impact strengths, machinability, wear, heat and corrosion resistance, thermal conductivity and expansion, electrical and magnetic properties. Effects of mass and section, and depth of chill are also mentioned, with a section on alloy white iron, and others on heat treatment, foundry practice, and specific applications of alloy cast iron. The bibliography carries nearly 500 references, and there are 111 figures.

The plots of properties vs. composition (varying alloy added to the same base iron) are seldom smooth, indicating that the trend of alloy effect may be materially disturbed by other factors. There are enough such plots to keep the reader from too implicit trust in any alloy as a wonder worker under all conditions. The importance of a suitable base iron to which to add the alloys is brought out throughout, both directly and by implication.

One of the most striking things in the whole handbook is the curve from hitherto unpublished work by Crosby on late addition of Si. The handbook is a very good job. It will appeal alike to the producer and the user of special cast iron.—H. W. GILLETT.

The Principles of Metallographic Laboratory Practice

George L. Kehl

McGraw-Hill Book Co., New York, 1939. Cloth, 6¼ x 9¼ in., 359 pages. Price $3.50.

The author indicates the purpose of this book in the preface—"a textbook of fundamental principles involved in metallographic laboratory practice—a book that will bridge the gap between theoretical physical metallurgy and its practical application in the laboratory."

The scope of this new publication is indicated by the subjects of the nine chapters: Preparation of Specimens, Etching of Specimens, Metallurgical Microscopes and Photomicrography, Principles of Photography, Macroscopy, Hardness Testing, Special Metallurgical Tests, Principles of Pyrometry and Pyrometric Practice, and Thermal Analysis. There is an appendix of valuable tables on pages 291-337. Each chapter contains references to original literature.

This text should be of most value to those who are beginning work in the metallographic laboratory, but there are doubtless many others who would be benefited by a better understanding of the fundamental principles involved. It should lead to improved techniques in most laboratories. Kehl's text appears to be suitable for course work in metallography but each teacher would have to outline his own experimental program. The independent student should get valuable information from this publication and could with rather limited equipment carry out his own educational course.

In general, the micrographs and macrographs are good and rather well reproduced. A valuable feature are the illustrations of good and bad techniques. In some cases the macrographs are at too low magnification to show as much as desirable. Most of the illustrations are of iron and steel and the non-ferrous metals have a rather small place. Hardness testing is presented in extensive form and most of the instruments are described. Hot-hardness testing was not mentioned, however. Special metallurgical tests include grain size, fracture tests, spark tests, magnetic tests and cupping tests.

This new publication is the best the reviewer has seen in describing the usual working tools of the metallography laboratory. It does not include such specialized equipment as that for X-ray and electron diffraction studies. It is neither a laboratory manual nor a text on physical metallurgy, but it does bridge a gap between the two and should be valuable to metallographers.—OSCAR E. HARDER.

The Microscope in Elementary Cast Iron Metallurgy

R. M. Allen

American Foundrymen's Association, Chicago, 1939. Cloth, 6¼ x 9¼ in., 143 pages. Price $3.00.

The author, a generally recognized authority in the metallography of cast iron, has published in this book material that formed the basis of a series of educational lectures that he delivered at the annual convention of the A. F. A., but they have been greatly expanded.

Success has attended the aim of the author to show the practical man that there is nothing particularly difficult about the use of the microscope nor its interpretation when fundamentals are understood.

The photomicrographs, as reproduced, are very fine, and demonstrate the skill and reputation of the author.—E. F. CONE.

Report of the National Physical Laboratory for 1938

His Majesty's Stationery Office, London, 1939. Paper, 6 x 9½ in., 147 pages. Price 2s, 6d.

Since space is lacking in the report for description of results, the volume serves primarily to show the topics studied. Some of those of metallurgical interest are: Thermal constants of steels, immersion thermocouple for steel, fatigue, creep, application of electron diffraction, measurement of surface finish, damping, fretting corrosion, cast crank shafts, welded pressure vessels, lubrication and seizure, age-hardening, aluminum and magnesium alloys, caustic embrittlement, and analytical methods, including gases in metals.—H. W. GILLETT.

CURRENT news

Dr. Hoyt Joins Battelle

As of June 1, Dr. S. L. Hoyt became associated with Battelle Memorial Institute, Columbus, Ohio, as metallurgical research advisor. For a number of years he has been a member of the editorial advisory board of METALS AND ALLOYS and was one of the original members.

Dr. Hoyt will act as technical advisor in the planning and conduct of metallurgical research at Battelle. The enlargement of the building and the rapid growth of sponsored research activity of the Institute has made necessary an increase in the staff.

Formerly director of metallurgical research of the A. O. Smith Corp., Milwaukee, Dr. Hoyt is one of the best known of American metallurgists. He brings a background of wide technical and commercial experience to his new work.

Battelle Enlarges Plant

Contracts have been let by Battelle Memorial Institute, Columbus, Ohio, for the construction of a new research laboratory to take care of the expanding volume of industrial research, according to Clyde E. Williams, director. American industrialists are becoming increasingly research-minded, he said, and predicted that the nation's facilities for research will have to be greatly expanded in the immediate future. The new construction consists of a wing extending from the end of the present main building that will provide approximately 50,000 sq. ft. of space on 5 floors. In this will be chemical and metallurgical laboratories, photographic and metallographic departments, physics laboratories, and a large industrial laboratory.

WANTED

1 Used Rockwell Hardness Tester Model 1R or 3R, in good condition.

BOX MA-143

Brazing Cu Conductor Arms with an Ag Alloy

The use of low temperature silver brazing alloys for joining heavy copper current conductors is growing rapidly, according to Handy and Harman, New York. Recently the trade papers have described a number of bus bar applications as used on electroplating installations and in the power plant.

A similar application is now being used by Sperry Products, Inc., New York, in building rail welding equipment. The current conductor arms, an important part of this welder, are made of copper bars ¼ in. thick by 6 in. wide. They are brazed to a copper casting with a brazing alloy containing a medium percentage of silver, which flows freely at 1175 deg. F. This alloy was selected for this application for four important reasons: (1) It makes joints which are ductile and high in tensile strength; (2) the electrical conductivity of the joints is as high as or higher than the copper itself; (3) joints of solid metal cannot oxidize and never require cleaning or servicing, and (4) the free flowing silver brazing alloy goes into the joint, little stays outside, little or no finishing work is needed.

The rail welder, a recent development by Sperry Products, Inc., joins railroad rails permanently into long lengths. Rails of standard 39 ft. length have been welded to form lengths of 1700 ft. and these lengths in turn have been welded together. The longest stretch measures 7700 ft. and is located near Schenectady, N. Y., out in the open (not in a tunnel) where it is subject to extreme variations of temperature and shows how the forces of expansion and contraction have been overcome. The particular welder in which the brazing described was done is being made for the Paulista Railway of Brazil, S.A.

Copper in G.M.'s World's Fair Building

An interesting use of copper is found in one of the large rooms—the automobile show room, Section E—of the Exhibit Building of the General Motors Corp., at the New York World's Fair, 1939. A copper-covered plywood is used as wall covering and also as a column and rail covering on the inside of the building. A total of 4,400 sq. ft. of this material was used in the building. The ceilings as well as the center column are covered with a copper fabric, 16,400 sq. ft. having been used.

In the automobile and Diesel motor display room, Section F, some of the walls and ceilings are covered with a brass fabric, a total of 27,000 sq. ft. having been used in the building.

J & L's Controlled Bessemer

The metallurgical department of the Jones & Laughlin Steel Corp., Pittsburgh, has announced the results of years of extensive research on the Bessemer converter for steel making. It is believed to be the first significant technical advance in Bessemer steel since the invention of the process. Published accounts of the company's announcement are about as follows: The patents which the company has applied for cover several different methods, but procedure which is being used consists of an ingenious arrangement of photo-electric cells which provide an instantaneous record of the rapid changes in the bessemer flame. In conjunction with the cells and as a part of the control system, a complete instrument panel provides accurate regulation of blowing conditions.

The new method, called the "bessemer flame control" has proven highly successful in achieving uniformity of quality in bessemer steel, according to the company which has conducted exhaustive tests of the new invention over a period of many months.

Until now, the company contends, control of the bessemer converter depended upon the skilled eyes of the blower who had sole responsibility in determining the proper "end point" or termination of the blow which has a definite relationship with quality results. The object of the research which resulted in this new method was to supplement the skill of the human eye with an invariable method that would not be affected by fatigue, inattention, poor physical condition, or other factors which affect the most skilled eyes at times.

It has been learned that the company's experiments resulting in the new method of controlling bessemer steel production, have been so successful that several additional studies involving fundamentals of bessemer steel making have been started by the company's pilot plant and laboratories, which will soon add a miniature bessemer converter to their equipment.

It is Jones & Laughlin's contention that their new method of aiding their blowers in flame control decisions by precision equipment will develop new applications for bessemer steels where uniform high quality steel is required. The company is also of the opinion that the "bessemer flame control" may influence the ultimate direction of steel making procedure.

The Electrochemical Society

The annual fall convention of The Electrochemical Society will be held at the Commodore Hotel, New York, Sept. 11 to 13. Visits to the World's Fair will take the place of plant visitations. Prof. Bradley Strughton, Lehigh University, will deliver the sixth Joseph W. Richards Memorial address—"Modern Marvels of Electrochemistry"—in the Hall of Science at the Fair.

Future conventions are announced as follows: Wernersville, Pa., April 26-29, 1940; Ottawa, Canada, Oct. 2 to 5, 1940; and Cleveland, Spring of 1941.

Officers of A.S.M.

Nominations for officers of the A. S. M. for the coming year are announced as follows: President, James P. Gill, Vanadium Alloys Co., Latrobe, Pa.; vice president, Dr. Oscar E. Harder, assistant director, Battelle Memorial Institute; treasurer (2 yrs.), Dr. Kent R. Van Horn, Aluminum Co. of America. The two directors nominated annually, are Dr. M. A. Grossman, Carnegie-Illinois Steel Co., Chicago, and H. J. French, International Nickel Co., New York. Election takes place at the National Metal Congress in Chicago, Oct. 23 to 27.

● Richard Rimbach has been appointed technical advisor to R. C. Enos, president of Standard Steel Spring Co., Coraopolis, Pa. He will work on the development and promotion of a new process for coating steel with a pore-free metallic coat which has successfully demonstrated its resistance to serve corrosion conditions in the Texas oil fields, it is claimed. Mr. Rimbach was formerly director of research, Standard Steel Car Co., editor of METALS AND ALLOYS and more recently consulting metallurgical engineer.

Summer Session on "Physics of Metals"

The University of Pittsburgh will be host this summer to several of the world's most outstanding authorities in the "Physics of Metals." A group of courses will be given from July 6 to Aug. 11 in the fundamental structure of metals and other solids. An attempt will be made to understand the nature of the forces which make pure metals and alloys hard or soft, ductile or brittle, good or bad conductors of electricity, etc. The following courses will be offered: 1. *"Introductory Electronic Structure of Metals"*, (6 weeks) by Dr. John C. Slater, head of the department of physics, Massachusetts Institute of Technology; 2. *"Elementary Atomic Physics"* (6 weeks) by Dr. M. F. Manning, University of Pittsburgh; 3. *"Modern Theory of Solids"* (3 weeks) by Dr. William Shockley, Bell Telephone Laboratories, New York; 4. *"Electrical and Magnetic Properties of Metals"* (3 weeks) by Dr. Frederick Seitz, University of Pennsylvania; 5. *"Introductory Statistical Mechanics* (6 weeks) by Dr. Edward U. Condon, Associate Director Westinghouse Research Laboratory; 6. *"Theory of Atomic Vibrations"* (6 weeks) by Dr. John C. Slater.

A booklet describing these courses may be obtained by writing to Prof E. Hutchisson, University of Pittsburgh, Pittsburgh.

• The Holden-Printz Co., 25 W. 34th St., New York, is the name of the firm formed by two well-known members of the New York Chapter of A.S.M. "Tim" Holden has been secretary of the chapter for 19 years and "Bill" Printz was a charter member. They represent several furnace equipment makers.

• C. Donald Dallas, president of Revere Copper & Brass, Inc., has announced the appointment of C. E. Kuthe as technical advisor to the company's Michigan Division. Mr. Kuthe is an alumnus of Case School of Applied Science, Cleveland, graduating as a B. S. in mechanical engineering in 1932, and securing his M. E. in 1937.

A.I.S.I. Takes Over Research

Research in steel technology formerly conducted by The Association of American Steel Manufacturers technical committees, with headquarters at Pittsburgh, was transferred to the technical committees of American Iron and Steel Institute, effective June 1. Announcement of the transfer was made jointly by the American Iron and Steel Institute and the Association of American Steel Manufacturers Technical Committees. The offices of the latter association, which was established some 40 yrs. ago, were closed as of June 1.

The standards for chemical compositions, physical properties, rolling tolerances and other permissible variations from specified dimensions originally promulgated by the Association of American Steel Manufacturers Technical Committees will hereafter be sponsored by American Iron and Steel Institute, and will be published as a part of its "Steel Product Manual."

• The Pittsburgh Steel Foundry Corp., announces the appointment of Parker F. Wilson as its new president. Mr. Wilson was associated: recently, with the Wheeling Steel Corp., and previously with the Otis Steel Corp., as vice president and general manager. G. A. Hassel, the company's former president, will continue with the company in the capacity of chairman of the board of directors.

• J. Frederic Wiese who, since 1935 has been assistant to vice president of Lukens Steel Co., Coatesville, Pa., has been appointed general manager of sales.

• The International Nickel Co., 67 Wall St., New York, has issued a revised "Hardness Conversion Table for Nickel Alloy Steels", available on request.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Candidate for Ph.D., with several years of industrial experience, expecting to receive his degree this Fall, desires a teaching position in metallurgy. Box MA-144.

POSITION WANTED: Metallurgical engineer; D.Sc. Over 10 years experience in industry and teaching. At present employed in teaching. Primarily desires industrial connection, will consider teaching. Excellent record and references. Research or production work desired. Available on short notice. Box MA-145.

POSITION WANTED: Metallurgical engineer interested in control and research. Single, 22 years old, B.S. in metallurgy M.I.T. '38. One year with consulting metallurgists. Experience in examination of mechanical and corrosion failures; physical, electrical, metallographic, and corrosion testing; heat treatment control; inspection of welds and electroplating; and stainless steel research. Available immediately, location immaterial. Box MA-146.

POSITION WANTED: Metallurgist, 27; married; M.S. in metallurgy; University of Arizona, '36; three years' experience as steel-mill metallurgical inspector, desires an instructorship in college which would enable him to work toward a doctorate on the side. Available September. Box MA-147.

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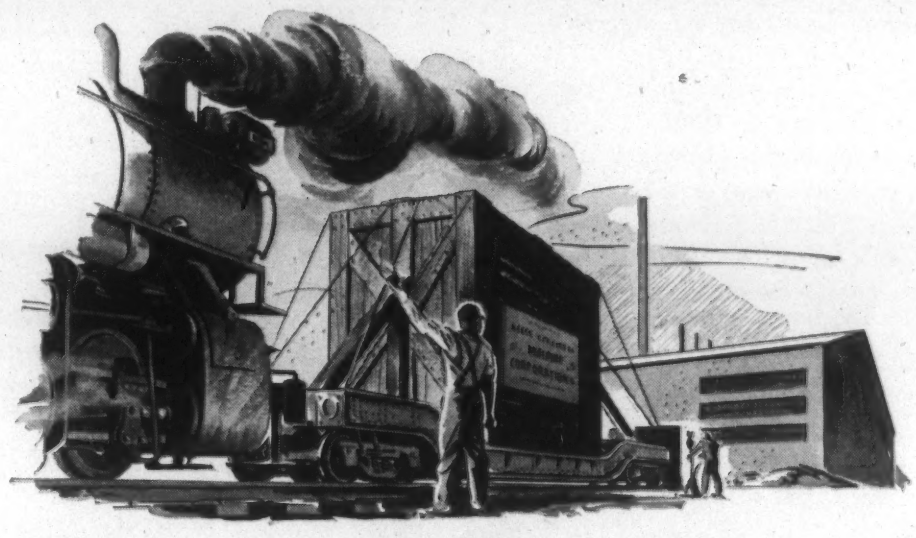

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Advertisers' Index

Ajax Electric Company, Inc. .....Outside Back Cover
Ajax Electric Furnace Corporation ..Outside Back Cover
Ajax Electrothermic Corporation
Outside Back Cover & MA 407
Ajax Metal Company .....Outside Back Cover
Aluminum Company of America.....MA 398, MA 399
American Bridge Company .....MA 406
American Car and Foundry Company .....MA 410
American Chain & Cable Company, Inc., Page Steel & Wire Division .....MA 425
American Cyanamid & Chemical Corporation ...MA 417
American Electric Furnace Company .....MA 396
American Gas Association .....MA 419
American Gas Furnace Company .....MA 414
American Machine & Metals, Inc., Riehle Testing Machine Division .....MA 434
Anaconda Sales Company .....MA 395
Andrews Steel Company .....MA 455
Arcos Corporation .....MA 426
Armstrong Cork Company .....A 13

Baker & Co., Inc. .....MA 416

Carborundum Company, Refractory Division
Inside Back Cover
Carnegie-Illinois Steel Corporation .....A 2, A 3
Chicago Steel Foundry Company .....MA 420
Climax Molybdenum Company
Insert between pages 226 and MA 391
Columbia Steel Company .....A 2, A 3, MA 406
Crucible Steel Company of America .....MA 409

De Witt Operated Hotels .....MA 448
Dietert Company, Harry W. .....MA 437
Dow Chemical Company, Dowmetal Division
Inside Front Cover
Driver Company, Wilbur B. .....MA 445
du Pont de Nemours & Co., Inc., E. I., R. & H. Chemicals Department .....MA 394

Electric Furnace Company .....MA 420
Electro Metallurgical Company .....MA 441

Fitzsimons Company .....A 16

Great Lakes Steel Corporation .....MA 443

Hevi Duty Electric Company .....MA 393
Hotel Adelphia .....MA 430

Illinois Testing Laboratories, Inc. .....MA 418
International Nickel Company, Inc. .....A 20, MA 397

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Johns-Manville Corporation .....MA 414
Jones & Laughlin Steel Corporation .....A 8, A 9

Leeds & Northrup Company .....MA 400
Lincoln Electric Company .....MA 428

Mahler Manufacturing Company .....MA 418
Mallory & Company, Inc., P. R. .....MA 427
Maurath, Inc. .....MA 423
Meehanite Metal Corporation .....A 22
Michiana Products Corporation .....A 17
Monarch Steel Company .....A 16
Morgan Construction Company .....A 4, A 5

National Industrial Advertisers Association .....MA 457
National Steel Corporation .....MA 443
Norton Company .....A 15

Page Steel & Wire Division, American Chain & Cable Company, Inc. .....MA 425
Pangborn Corporation .....MA 411
Pittsburgh Lectromelt Furnace Corporation .....MA 407

Republic Steel Corporation .....A 6, A 7
Riehle Testing Machine Division, American Machine & Metals, Inc. .....MA 434

St. Joseph Lead Company .....MA 392
Scomet Engineering Company .....MA 447
Scott Company, Henry L. .....MA 435
Spencer Turbine Company .....MA 415
Stone & Webster Engineering Corporation ....A 4, A 5

Taylor Sons Company, Charles .....MA 413
Thermal Syndicate, Ltd. .....MA 416
Timken Roller Bearing Company Steel & Tube Division .....A 14
Titanium Alloy Manufacturing Company .....MA 405

Union Carbide and Carbon Corporation .....MA 441
United States Steel Corporation .....A 2, A 3, MA 406
United States Steel Products Company .A 2, A 3, MA 406

Vanadium Corporation of America .....A 19

Westinghouse Electric & Manufacturing Company MA 421
Wilson Mechanical Instrument Company, Inc. ..MA 435

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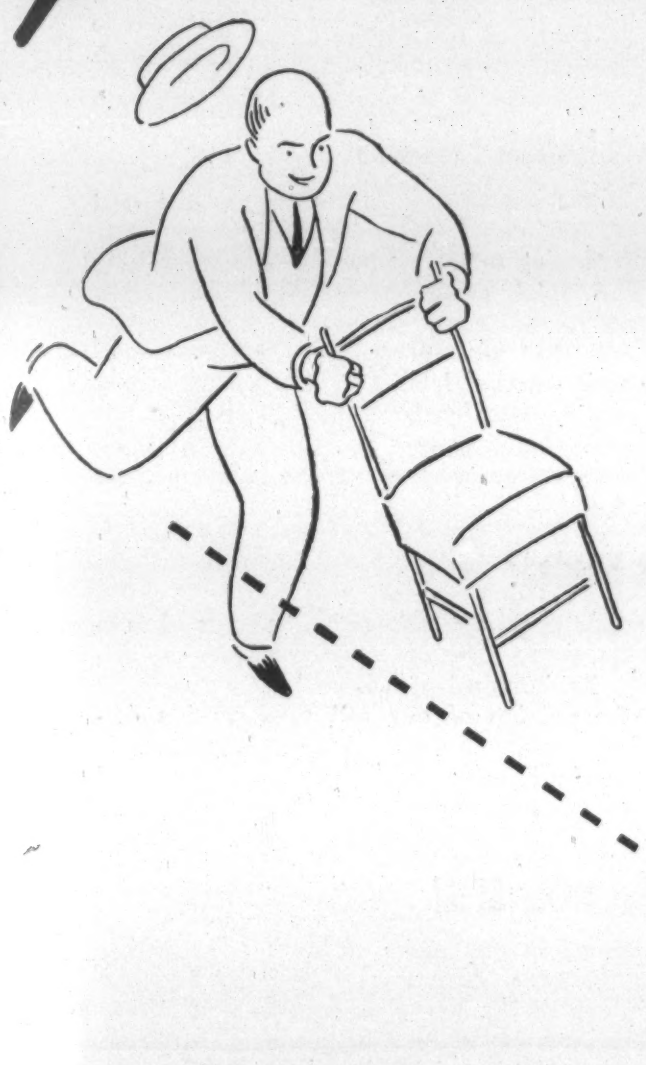

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trends

By Edwin F. Cone, Editor

Aircraft of the Future

Igor Sikorsky, in an address before a local chapter of a technical society, discussing, among many other interesting things, the part the metallurgical engineer must play in building aircraft of the future, pointed out that, for the mammoth planes, economical metals (or plastics) of high strength/weight ratio and superior corrosion resistance must be available. He implied that duralumin and certain magnesium alloys will probably be superseded by other materials. If planes can ever fly at super-high altitudes, bearings that run without lubrication will be required.

Less Weight—More Payload

The president of the Aluminum Association is credited with saying that "a modern transport plane, such as the 21-passenger Club Flagship in use on a prominent airline, weighs only 8 lbs. for every pound of passenger or freight carried. Not long ago airplanes weighed 20 lbs. for each pound of payload. This move towards light weight . . . can truthfully be said to be the most swiftly engineering trend we have today." A testimonial to progress in metallurgical engineering.

Insulated Furnaces

There have in recent years been rapid strides in the use of insulation on open-hearth furnaces. More companies have more furnaces insulated than ever before. An authority on refractories of a large steel company, speaking at a recent technical convention, declared that he is "sold 100 per cent" on insulated open-hearth furnaces, top and bottom, and that any type of furnace except a blast furnace could be insulated advantageously.

Cement-Bonded Molds

Since its first introduction in foundry molding practice, the cement bonded mold has grown in popularity and use. We are told that there are now at least 20 users of this process.

Controlled Atmospheres

Controlled atmospheres are not confined to the heat treatment of steel. Their use in the annealing of malleable iron is on the increase and there are said to be several installations where this modification of old practice is successful.

Residual Metals in O-H Steel

The trend in the accumulation of residual alloying metals over a period of years, as demonstrated in an article in our June issue, has been so uniform that those who have been in charge have decided to wait 5 yrs. before making another series of analyses. This is probably wise. We wonder, however, if the investigation scheduled for 1943 will not show a larger percentage of certain residual metals, due to the possible greater use of the low alloy, high strength steels and their accumulation as scrap.

Electric Steel Melting Furnaces

The trend in the use of electric furnaces in the steel foundry industry continues to favor the acid process. Finster, in his contribution to the symposium on steel melting practice at the A. F. A. annual convention in May, states that the majority of the arc furnaces for steel foundry use are acid line. In 1937, quoting statistics, he says that, of some 265 foundries in the U. S., 175 were making all or part of their steel castings by the electric process. A survey for 1937 showed 264 electric arc furnaces and 18 induction. From reports we have, the next survey will show an increase.

Better Rolls Needed?

The continuous strip mill is said to be the cause of some trouble for roll makers. The development of the continuous mill, with its increased speeds and no intermittent operation, in the opinion of one roll producer has outstripped technical progress in the manufacture of rolls. Roll quality and properties have not fully kept up with increased demands. There has been too much failure of rolls, it is claimed.

Improving Bessemer Steel

We are interested in the results of Jones & Laughlin's experiments in the more accurate control of the Bessemer converter by means of equipment using the photoelectric cell. The open-hearth has gone a long way in automatic control by instruments with highly beneficial results on to quality and other advances. Does this newer development mean more uniform and higher quality Bessemer steel and a larger use of this melting medium?

Weight of a Pier Reduced

Cutting down the load imposed on a pier 20 per cent below what it would have been had carbon steels been used is a recent interesting use of the low-alloy, high strength steels. According to an article in *Railway Age*, the use of one of the new steels in new side-wall loading machines on a C. & O. coal pier at Newport News, Va., made possible the installation of the machines.

Our Electric Furnaces Abroad

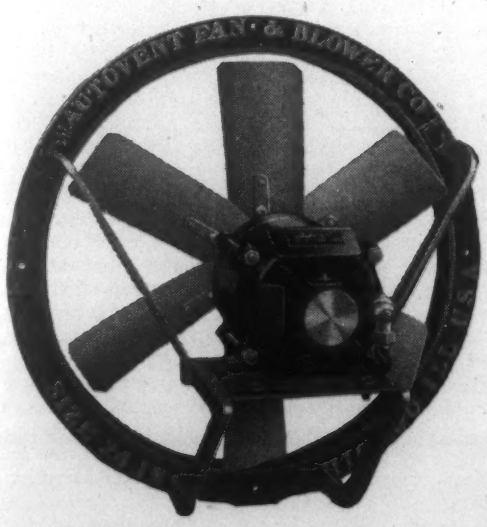
We heard recently that our foreign business in electric melting furnaces was larger than in many years. Consulting our official foreign trade data we find that in 1938, the total exports of "industrial electric furnaces, ovens and other heating devices" was $2,107,083 or $175,600 worth per month. The corresponding data for the first quarter of 1939 are $631,136 or at the rate of $210,345 monthly. This year's statistics are broken down into "electric melting furnaces and parts," "heat treating furnaces and parts" and "other industrial heating devices and parts." For the first item the total to April 1 is $421,795. Thus the trend in foreign demand for this equipment is decidedly upward.

New Equipment and Materials

Autovent Special Fans with Protective "Heresite" Coatings

The Autovent Fan & Blower Co., Chicago, announces a new treatment on their acid-moisture proof and vapor-explosion proof propeller fans that goes a step further in the protection of fans against corrosion and explosion, it is claimed.

This new chemical coating is known as "Heresite" and is especially recommended for use on fan wheels where extremely corrosive and highly concentrated acid or gas fume conditions prevail. The fan wheels are given multiple coats of Heresite baked finish at a temperature of 375°F. Extensive tests by the company are claimed to prove that this patented treatment keeps severest acid and practically all metal corroding substances from de-



stroying the metal to which it is applied. Where acid-moisture proof fans are required, Heresite coated fan wheels are of heavy gage steel, powered by fully enclosed round body motors that provide positive winding protection against all fumes and moisture. For installations where acid and fume conditions are less severe, the fan wheels are treated with three coats of Bakelite lacquer.

The vapor-explosion proof units have fan wheels of copper, brass, or other non-ferrous metals and motors bearing Underwriters Label, Class 1, Group D rating. Non-ferrous fan wheels used on vapor-explosion proof fans can also be treated with Heresite where severe corrosive fumes are handled. Special construction features of motor meet the specifications approved by the National Board of Fire Underwriters. Exclusive Autovent centripetal fan wheel construction, no churning of air and non-overloading power characteristic, are pointed to as feature attractions of these units just as in their "Complete Line" of ventilating products.

Autovent has prepared a bulletin describing Heresite treated fans.

Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts not more than 2 in. wide.

New Types of Meehanite

As a result of cooperative research by members of the Meehanite Research Institute of America, Inc., Pittsburgh, two new types of Meehanite Metal have been developed, which are to be known as: "Super A Meehanite" and "Super WH Meehanite." These two new types are claimed to possess some distinctive engineering properties and are expected to fill the need for working materials possessing such qualities. Production of these two types of metal is covered by new patents issued to the Meehanite Metal Corp., Pittsburgh.

Super A Meehanite is an alloyed Meehanite, using copper largely as the base alloy (Patent No. 2,086,098). This metal has been found to provide a great increase in hardness and wearing qualities, accompanied by an actual improvement in machinability. So far as is known, this is the first time increased hardness has been achieved without increased difficulty in machining. For example, Super A Meehanite at 269 Br. was found to machine 20% faster than alloy cast iron at 207 Br.

During the past 12 mos., many practical applications are said to have been made in this metal with successful results. For example, it has been found to be particularly adaptable to the construction of internal combustion engines, marine cylinders, and machinery of the type in which smooth running qualities are of primary importance. It has also found use in the production of large gears, piston rings, and other parts operating under severe wearing conditions.

No sacrifice of other physical properties is said to be necessary to obtain these results. The metal is described as having a high modulus of elasticity, a good degree of toughness, and a tensile strength in excess of 50,000 lbs. per sq. in.; in fact, no values are below the requirements of a good No. 50 A.S.T.M. iron.

Super WH Meehanite is described as an unusually wear-resistant material possessing a good combination of physical properties and may be made with Brinell hardnesses up to 578, according to the service requirements of the application. This metal has found practical use in castings subjected to extremely severe wear, such as ball mill liners, muller tires, and pan bottoms.

Flame Descaling Apparatus

Illustrated is the new Oxy-acetylene Descaling Apparatus of the Air Reduction Sales Co., 60 E. 42nd St., New York, recently developed to remove scale and other similar accumulations from iron and steel by rapidly heating such deposits with the multi-flame tips, thereby causing the cracking-off of the scale as a result of the

differential expansion between the scale and the base metal. This process removes scale from ingots, billets and slabs to expose seams and defects for inspection prior to scarfing or chipping, from forgings and steel castings prior to machining and steel castings after annealing. Where necessary, the apparatus is mounted on wheeled carriages for ease in travel across steel surfaces.

A secondary, but equally important function of the apparatus, is the process of driving out the occluded moisture from within and beneath the surface scale of structural steel and plate by rapidly heating the surface with the high temperature flames, leaving a warmed surface for painting. Immediately after the flame application, the surface is wire-brushed and swept clean of loosened scale particles and dust. Painting follows before recondensation of moisture occurs on the surface. An ideal paint base is thus said to be provided and danger of the further loosening of the tenacious protective mill-scale through weathering is minimized.

"Rayotube"—A Temperature Detector

By means of a temperature detector which "looks" at heat from a safe location, many plants, it is reported, are now getting continuous data from points never before detectable; are getting, at lower cost, more accurate data than they used to get; or are getting it more quickly. Called a "Rayotube", this detector can sight on work in motion. It is said to be safe from damaging heat, sealed against contaminating gases, and virtually unaffected by vibration. A description of the Rayotube is contained in a fully illustrated 6-page folder, issued by the Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

Portable Brinell Meter

The improved portable "Brinell Meter" is said to simultaneously make impressions in a reference bar and the material to be tested. The outfit consists of an instrument within which to nest a standard reference bar. The standard reference bar is supported in contact with a standard 10 mm. steel Brinell ball. The assembly is then placed in position on the surface of the material to be tested. The Brinell ball produces a simultaneous impression in the bar and in the surface of the material under test. The impression diameters are then compared and by reference to a direct reading hardness table provided for the reference bar, the Brinell hardness of the material is quickly noted. By the same token the tensile strength of the material is quickly computed. The instrument is equipped with a Binocular sight bar spacer by which to uniformly space impressions on the test bar. Louis C. Eitzen Co., 280 Broadway, New York, is the seller.

Compact, Low-Cost Welder

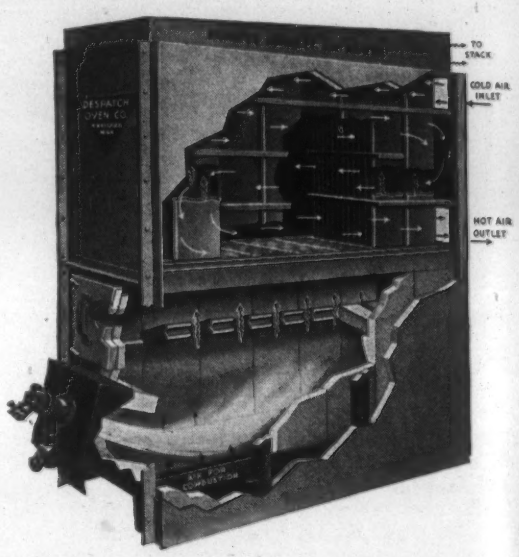
The Harnischfeger Corp., of Milwaukee, announces the new "P&H-Hansen Model WA-200" square frame welder for multi-arc service. Claimed as representing the last word in simplicity, compactness, ease in operation, this is a precision built welder whose design enables it to be built with the practical economies of modern mass production. The WA-200 requires less than 3½ sq. ft. of floor space, offers a welding range from 40 to 225 amps. It is built along extremely simple lines, having but two major parts—the one-piece frame and the rotating member itself. All attachments such as external exciters, reactors, resistors, rheostats or separate stabilizers are absent. Spring-mounted louvres can be snapped on and off to make periodic inspection of brushes and commutator, or for minor adjustments. Top and plates are also easily removed. The rotating member is statically and dynamically balanced.

Indirect Air Heater

The Despatch Oven Co., Minneapolis, Minn., has announced the new "Despatch Indirect Air Heater," gas and oil heated, which is claimed the outstanding heater development in two decades. Because of the many advantages of this new heater, it is highly recommended for ovens, dryers, and space heating.

Briefly, the Despatch Indirect Air Heater incorporates many new features that practically eliminate the maintenance and the replacement of parts that have been necessary on previous heaters of this type which have been on the market for about 20 yrs.

One feature is the new arrangement of the heat exchanger. It is arranged with a heavy duty alloy cast protecting plate that shields the tubes in the heat exchanger from the radiant heat of the combustion chamber. This



added protection feature in Despatch Indirect Air Heaters assists in preventing burned out tubes which are expensive to replace and which cause costly shutdowns in the production line when repairs are being made. The heat exchanger consists of 88 individual tubes which increase the normal area for radiation. Tubes are staggered to produce the greatest possible wiping action of the air as it passes through the heat exchanger. Resistance to air passage through the exchanger is very low.

Another feature is that only one burner is used to obtain 500,000 B.t.u. rating. This is claimed to be 50 to 75% less number of burners than are required on available indirect air heaters of the same B.t.u. rating. Of course, the smaller number of burners per installation reduce maintenance costs, and the possibility of becoming out of adjustment. The burner equipment used is a low pressure proportioning type, which keeps a constant ratio between the air and the fuel being used, whether gas or oil. The perfect proportioning promotes high efficiency of operation but, most important, eliminates soot and dirt which reduce maintenance of cleaning heat exchanger tubes to an absolute minimum. This reduced maintenance cost runs into savings of thousands of dollars depending upon the heater requirements.

Another feature is the arrangement of the combustion chamber so that there is no flame impingement on metal parts. This assures long life of the heat exchanger parts. There are numerous other features incorporated into the design of this new Despatch Indirect Gas and Oil Fired Heater.

Electric Eye Control

"Photoswitch," the electric eye control, has been developed for industry by Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass. Many industrial concerns are reported finding in Photoswitch equipment a simple method of automatic control of mechanisms and processes, which has been designed to bring at last the many advantages of photo-electric control to industry at low cost. It is simple in construction, positive in operation, and guaranteed. It is furnished in a dust-proof, water-proof housing, and is readily installed in any location. It contains no sensitive parts, a fact which makes it outstanding in the photo-electric field.

Standard types are supplied complete with light source at net prices ranging between $40 and $50.

"Certain Curtain" pre-heat and hardening furnaces at Corbin Screw Corporation Division of American Hardware Corporation.

Products of American Hardware Corporation

Corbin Screw Corp. Div. Machine & Wood Screws, Chain, Automatic Screw Machine Products, Tachometers.

Russell & Erwin Div. "Russwin" Builders Hdwe.

P. & F. Corbin Div. "Corbin" Builders Hdwe.

Corbin Cabinet Lock Div. Padlocks, Cabinet Locks, Post Office Equipment, Bars for Hotels, Taverns, Homes.

How 4 plants save with "Certain Curtain" hardening at American Hardware Corporation

With four plants in New Britain, Conn., the tool heat treating problems of the American Hardware Corporation are many and varied. Until two years ago, the Corbin Screw Corporation Division used oil and gas fired furnaces for their high speed steel tools. At that time they installed the "Certain Curtain" team shown above. Today this pair of furnaces handles all the high speed tool work for *all four* divisions, with noticeably longer tool life resulting. "While no attempt has been made to keep exact record of savings," they say "we are satisfied that the furnaces, installed a little less than two years ago, have long since saved their cost for us."

For latest data on the world's leading controlled-atmosphere furnaces, request new Bulletin 105 by writing C. I. Hayes, Inc., Established 1905, 129 Baker St., Providence, R. I.

5 points explaining "Certain Curtain" leadership

1. "Certain Curtain" performance accepted as The Standard, even by other makers who often claim "as good as 'Certain Curtain'."
2. Through definite savings in tool cost, these furnaces frequently repay their cost in 6 to 18 months.
3. With approximately 1,000 furnaces in the U. S. and 16 foreign countries, "Certain Curtain" is literally the world leader.
4. The patented basic principle of "Certain Curtain" atmosphere control remains unchanged, while scope has greatly widened through adaptation and mechanical refinements.
5. After 11 years, with new methods coming and going, "Certain Curtain" is more firmly established than ever as THE LEADER among controlled-atmosphere furnaces.

ELECTRIC CERTAIN CURTAIN FURNACES

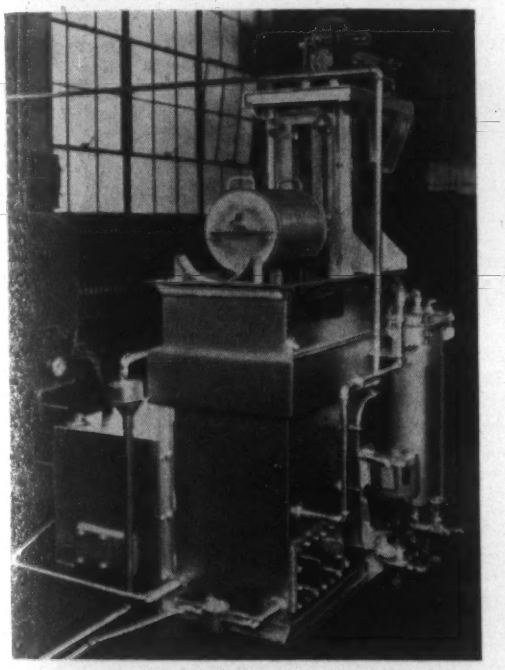
FOR 11 YEARS THE LEADER IN CONTROLLED-ATMOSPHERE HEAT TREATMENT

Special 1-Dip Detrex Degreaser With Rotating Baskets

An important new development in which it is said that degreasing can be applied to cup-shaped work, is effected through the rotating basket design of Detrex degreaser. This machine has been recently developed and marketed by Detroit Rex Products Co., 13005 Hillview Ave., Detroit.

Outstanding economies in the cleaning of cup-shaped work are claimed made by this new rotating basket design. It is used on work which would otherwise tend to trap solvent and cause heavy carryout. Work comes from the degreaser clean, warm, and dry—free from the last trace of solvent vapors, chips and abrasive. Engineering balance of heat input against production, together with high capacity water jacket condenser and other features, which maintain the vapor line at the mid-point of the condenser, have effected further cleaning economies, it is claimed.

This degreaser consists essentially of a one-dip or liquid-vapor design with storage tank and a special automatic elevator mechanism which raises and lowers the rotating baskets. A continuous filter is used to keep the boiling chamber free of insoluble material, and a continuous operating Detrex Solvent Still is used to remove oil contamination. By this means, the work is always immersed into clean solvent, and a final pure-vapor cleaning action is



given as the work is raised out of the boiling solution.

A clean solvent storage tank is located at the rear side of the degreaser. The elevator drive mechanism is shown on a platform above the structural work (hood shields have been removed from the upper structural work in order to show details of elevator mechanism and the rotating basket for holding the work). The elevator drive is effected by a combination-right-angle-geared-head motor and brake, complete with a reversing switch, vacuum tube time relay, limit switch, and push button station. Electrical controls, water separator, and vapor trap are located on the end of the machine opposite the loading-unloading station. The boiling compartment has a removable cleanout door and drain valve and is equipped with a steam jacketed bottom and steam pressure relief valve.

The drum-shaped mesh basket, with which this machine is equipped for rotating and draining the work, fits over a spindle which is attached to the elevator mechanism and has a gear and pinion device to cause rotation of the basket during its descending and ascending travel. A push-button station located adjacent to the loading end operates the elevator drive mechanism, while limit switches and a time interval control govern the travel of the elevator and basket. After the set time interval for cleaning in the boiling solution, the load returns automatically to the loading-unloading station.

This rotating-basket design of degreaser is manufactured in various sizes ranging in capacity up to 2 tons per hr. to suit individual requirements. One unit has the following overall dimensions: Length, 4 ft.; width, 4 ft. 8 in.; height, 7 ft. 2 in. The operating height to center line of basket spindle is 4 ft. 8 in. The rotating baskets are 12 in. diameter by 15 in. long. The solvent capacity of the boiling chamber is 61 gals., and the storage tank is of sufficient size to hold all of the solvent from the machine. The approximate weight is 1,600 lbs., not including accessory equipment and solvent still.

Stainless Steel Welding Electrode

The Lincoln Electric Co., Cleveland, announces a new arc welding electrode of the 18-8 type, having 3½% molybdenum.

The new electrode, designated "Stainweld C," was developed by Lincoln engineers to meet a demand for an arc welding electrode to weld the considerable number of stainless steels on the market which contain approximately 3½% molybdenum. "Stainweld C" provides weld metal of proper physical and chemical properties for welding such steels. A coating is provided on the electrode which prevents oxidation of the weld metal and keeps the analysis of the deposited metal virtually the same as the parent metal. Due to this, welds are of high tensile strength and ductility and possess similar corrosion resistance qualities to the parent metal.

The physical properties of "Stainweld C" are similar to 18-8 stainless steel. The electrode's advantages will be particularly apparent in bleaching and dyeing operations where welding is done on acid resisting pipes, agitator coils, evaporators, dye vat linings, dyeing equipment, pumps, rolls, etc.; and in the paper and pulp industry for equipment such as digesters, tanks, tubing, piping, fittings, etc.

The electrode is made in three sizes: ⅛, 5/32 and 3/16 in. and 11½ in. lengths, in 25-lb. packages.

IMPORTANT NEWS
TO ALL MANUFACTURERS WHO JOIN METALS...

NEW LOW PRICES FOR SIL-FOS AND EASY-FLO BRAZING ALLOYS

In line with the recent drop in the price of silver, Handy & Harman have *substantially reduced* the prices of Sil-Fos and Easy-Flo.

NOW SIL-FOS is 20c per lb. less.
EASY-FLO is 3½c per oz. less.

Even at the old prices, Sil-Fos and Easy-Flo reduced metal joining costs substantially for thousands of manufacturers. At the same time they provided strong, ductile, leak-tight joints.

Now, lower prices make Sil-Fos and Easy-Flo brazing even more economical.

If you have never tried these fast working, low temperature silver brazing alloys, don't delay any longer. Without obligation, we'll gladly demonstrate, in your plant, how to join ferrous or non-ferrous metals on one of your jobs—or we'll braze it in our laboratory and send it to you for inspection and test. Check the coupon for details about Sil-Fos and Easy-Flo and the new price list. Also, use it if you want a demonstration.

HANDY AND HARMAN
82 Fulton St., New York, N. Y.

Agents in Principal Cities—In Canada: HANDY & HARMAN of Canada, Ltd., Toronto

CHECK AND MAIL THE COUPON TODAY

HANDY & HARMAN MA-8
82 Fulton St.
New York, N. Y.

☐ Send me the new SIL-FOS and EASY-FLO Price List
☐ Have your representative call and demonstrate

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COMPANY .....
ADDRESS .....
CITY ..... STATE .....

Wrap Rax—A Protective Coating for Plating Racks

"Wrap Rax" is a new synthetic thermoplastic resin in tape form which is characterized by its ability to resist chemically, all of the cleaning, pickling and plating solutions commonly used in electroplating. It is therefore ideally suited for use as a coating for electroplating racks. This coating will also withstand the abrasion, and the mechanical and thermal shocks encountered in ordinary use without cracking or breaking, and its excellent dielectric properties provide perfect insulation. It is marketed by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies. The basic material is made by the Halowax Div. of the Bakelite Corp.

The tape is available at this time in 1-lb. rolls of a standard width, ¾ in. It can be obtained, however, in any width up to several inches. A standard roll contains approximately 250 ft. of the tape, a sufficient amount to wrap several dozen average sized racks. It is applied in the same manner as friction tape.

Extensive tests are claimed to indicate that the Wrap Rax coating is not affected by either strong alkalies, still or electro-cleaning solutions or by the strongest acid pickles. The usual electroplating solutions, including chromium, do not attack or weaken the coating, nor do the solutions themselves become contaminated. As the surface of the rack coated with Wrap Rax is smooth and glass-like after the sealing operation, it does not absorb or entrap solution, eliminating the danger of contaminating one bath by drag-in from another. Racks coated with Wrap Rax that have been in service for some time and have been injured mechanically by rough handling can be repaired very easily.

DEEP *cases* in SHORTER Treating Time

use du Pont CARBURIZING SALT

Deep high carbon cases (0.035" and over) are easily obtained on a wide variety of steels in about one-half the usual time for pack hardening and other methods. That is why prominent manufacturers are now using new du Pont Carburizing Salt. At the usual carburizing temperatures this specially prepared cyanide mixture produces high-carbon cases with a very low nitrogen content. Accurate control of the case depth is possible because of the uniform rate of carbon penetration, high conductivity and unusual stability of du Pont Carburizing Salt.

Plan to visit the du Pont exhibits at the *Golden Gate International Exposition* in San Francisco and at the *New York World's Fair.*

DU PONT

E. I. DU PONT DE NEMOURS & COMPANY, INC.
The R. & H. Chemicals Department
Wilmington, Delaware
District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

Iron 99.99 Per Cent Pure

The world's costliest iron, a metal 99.99 per cent pure, is being made at the Research Laboratories of the Westinghouse Electric & Mfg. Co., under the direction of Dr. T. D. Yensen, manager of the magnetic division. Although the world's consumption of this iron does not exceed 1,000 lbs. a yr., chemists and metallurgists in the laboratories find it of vital importance, for its spectrum makes available nature's scale of the metals. By comparing spectrograms of samples with the pure iron standard, investigators are now able to analyze all metallic elements.

For the past 10 years, ever since Dr. Yensen and his associates succeeded in removing all but a few hundredths of one per cent of the metal's impurities, the Westinghouse company has supplied much of the world's needs of spectrographically pure iron, through the distribution channels of optical manufacturers.

A raw material already low in copper, nickel, and cobalt content is used as one of two electrodes in an electrolysis process. When an electric current is introduced into a chemical solution of iron salts, the iron molecules travel through the solution to the second electrode, made of lead. Except for about 0.01% of carbon, the other impurities in the iron are left on the first electrode.

The resultant porous mass of iron is heated at high temperature in a hydrogen atmosphere to remove the oxides formed during transfer and storage. Next, the iron is placed in a high-frequency induction furnace to remove the remaining carbon and oxygen. By a special annealing process Dr. Yensen is now able to refine this iron to a carbon content of only one-thousandth of one per cent.

The result is an iron purer than nature has ever made, but despite its purity this iron is still a complex mixture of 27 elements, as follows: Silicon, less than 0.01%; oxygen, less than 0.01%; carbon, less than 0.005%; sulphur, less than 0.005%; nitrogen, less than 0.004%; phosphorus, less than 0.003%; manganese, less than 0.003%; zinc, less than 0.002%; molybdenum, less than 0.001%; copper, less than 0.001%; lead, less than 0.0004%; tin, less than 0.0002%; barium, less than 0.0001%; titanium, less than 0.0001%; silver, aluminum, arsenic, boron, calcium, cobalt, chromium, gallium, iridium, magnesium, nickel, vanadium, and tungsten, slight traces, but each less than 0.00005%.

By means of the Yensen research procedure Westinghouse can produce a year's supply of the metal in less than a week. The iron is now cast in 200-lb. ingots, so soft that they can be pounded into billets at the low forging temperature of about 1600 deg. F. The billets are then rolled into long rods ¼ or ⅜ in. in diameter. To eliminate surface oxidation they are again heated in a hydrogen atmosphere at a temperature of more than 2,000 deg. and held at this temperature for 24 hrs. before cooling. The finished rods then travel to all quarters of the globe, to serve as laboratory standards.

"Nusite"—for Hardening High-Speed Steel

Heavier cuts and feeds, at normal or even slightly increased speeds, together with longer tool life, are said to be possible now with cobalt high-speed steel when hardened by a process known as "Nusite." A most extraordinary strength and toughness are said to result from this treatment, at the usual hardness for cutting tools. The process is not claimed a cure-all, but is believed to fill the gap between high-speed steel as ordinarily hardened, and the various carbides.

On tough cutting jobs, long runs, or where it is desirable to "hog" out the metal, Nusite is reported to increase production and prolong the life of the tool. Perfection Tool & Metal Heat Treating Co., 1740-46 W. Hubbard St., Chicago, a commercial heat-treating firm of more than 20 yrs.' standing, recently took over this process. They now treat cobalt high-speed steel in this manner on request—and also sell bits, flats, or squares so treated—under a guarantee of satisfaction.

Large tools can be tipped with Nusite for economy. No special grinding wheel is required to grind it.

An Illuminated Magnifier

Pike-O-Scope is claimed to be a new and original illuminated magnifier initially developed to examine the inside portion of a valve and to permit close inspection of the valve seat.

The unit consists of a set of achromatic triple lenses of the finest grade, threaded into a Bakelite frame to permit proper focusing, and a special "Dalite" lamp in a molded-plastic cylinder which also serves as a handle. At the outer end of this cylinder is a (7 ft.) cord carrying a circuit switch and plug for connection to any electric outlet. This electric unit can be substituted for a flash-light case, illuminated by two dry cell batteries, which can be obtained at any hardware or electrical store. Perfect illumination is given and defects can be readily seen at a distance of 2 ft. from the eye. The Pike-O-Scope can be used for all general inspections, including inside examination of cylinders, valves, irregular surfaces, etc. It is made by E. W. Pike & Co., Elizabeth, N. J.

Black Molybdenum Finishes

A new and superior black electroplated coating for decorative hardware, art objects, ash trays, flashlight cases, lamps, bookends, business machines and automobile hardware was discussed in a paper, titled "Electrodeposition of Black Molybdenum Finishes," presented before the American Electroplaters' Society convention, at Asbury Park, N. J., in June. The authors of the paper are R. A. Hoffman and R. O. Hull, of E. I. du Pont de Nemours & Co.

"In contrast to prior processes," the authors said, "it has been found possible to produce highly lustrous, deep black deposits from a solution containing essentially ammonium molybdate, nickel sulphate, and boric acid."

It was pointed out that previously various efforts had been made to use molybdenum compounds to produce colored deposits. So far as could be determined, however, no use had been made of molybdenum with nickel to give the black deposits obtainable with the du Pont process.

"Black molybdenum plating offers very attractive possibilities as a process that is markedly superior in many respects to existing black nickel plating and similar black coating processes," the du Pont chemists claimed.

The Linco Gold Saver

The "Linco Gold Saver" is a wet recovery machine that has been thoroughly tested and proven by use, in lode and placer mines from Alaska to Mexico, according to the Linco Engineering Co., 2816 Gilroy St., Los Angeles, Cal. It is made in three sizes. It is sturdily constructed of highest grade materials and of alloys resistant to corrosion and abrasion. The gears and anti-friction bearings operate in a bath of oil, sealed to prevent contamination with water or grit as well as to prevent loss of oil.

It is stated that it will successfully recover all of the coarser gold, but its unique feature is its ability to recover the fine "flour" or "paint" gold, which has heretofore proven difficult or impossible. Platinum and some forms of floured mercury are also recoverable. It is not a concentrator, but is for the purpose of separating free gold from gravel or ground ore. Sulphide and other concentrates are rejected.

A Hard Surfacing Powder

"Surfaceweld A" is a fine grained alloyed powder to be applied with the carbon arc, giving a smooth dense hard (abrasion resistant) surface. It can be applied in a very thin layer if desired. This material when properly applied is claimed to give a coating with a hardness of approximately Rockwell 54C. This hardness will vary somewhat depending upon the amount of admixture with the base metal to which it is applied. It should be noted, however, that hardness has little relation to abrasion resistance.

This alloy is said to develop its full hardness in the as-deposited condition, maintains its hardness at high temperatures and resists scaling at high temperatures. The deposit cannot be softened by annealing. Under many conditions it is quite corrosion resistant, but this is not universally so. Corrosion resistance will compare favorably with that of stainless steel.

Its resistance to abrasion is excellent. One of its big advantages, it is said, is that it can be applied in very thin and extremely smooth layers. A deposit as thin as 0.025 in. can be applied to light metal, such as 12 to 20 gage.

Spread powder evenly over area to be surfaced and to a depth of 2 to 3 times the desired thickness of deposit. Use a sharp, well-tapered carbon with negative (normal) polarity and fuse down with a weaving motion. The exact heat required will depend on the size of the work. Use enough heat to obtain a free-flowing puddle but not enough to dig into the base metal. Whenever possible weave the full width of desired deposit and build to desired depth in one pass. If more than one pass is required, the work must be kept hot. Avoid heavy deposits. "Surfaceweld A" is shipped in 1 lb. and 15 lb. cans by the Lincoln Electric Co., Cleveland.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 6 of a Series

Typical Bubbles that Float the Mineral

THE FLOTATION PROCESS

At the Balmat Mill of the St. Joseph Lead Company 1,000 tons of ore are hoisted daily, crushed and ground to the size of sand, and mixed with water. This pulp, with carefully controlled combinations of chemical reagents, is agitated in the St. Joe flotation machines by forcing air to the bottom of the tanks. The first combination makes the lead sulphide adhere to the bubbles and overflow at the top; the next combination "floats" the zinc sulphide, and the final circuit "floats" the iron pyrites concentrates.

After filtering and drying, the zinc concentrates, averaging 57% zinc, are loaded into box cars and shipped to the Josephtown Smelter near Pittsburgh, Pa., where they are converted by the electro-thermic process into St. Joe Slab Zinc.

ST. JOSEPH LEAD COMPANY

250 PARK AVENUE • NEW YORK

ELdorado 5-3200

PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Precision Measuring Standards

The George Scherr Co., 128 Lafayette St., New York, has placed upon the market a new

set of precision measuring standards under the trade name of "Ultra-Chex." The set consists of nine standards accurate to 8 millionths of an inch and will make 71 combinations in steps of $\frac{1}{16}$ in. up to $4\frac{7}{16}$" and 41 combinations in steps of 0.100 in. up to 4.1 in.

Of outstanding interest is the fact that this set is available for less than $20., placing highest precision accuracy within the reach of the smallest shop. Also available with the Ultra-Chex set is the Scherr Optical Parallel, accurate in planeness within 4 millionths. This is used to check the parallelism of micrometer anvils by observing light interference bands on both anvils.

A new 6-page folder has been issued showing various uses of the Ultra-Chex in actual toolmaker's and shop work, such as checking lead accuracy of micrometers, inspecting and setting micrometers, setting height gages and adjustable snap gages, and setting and inspecting measuring machines and machine tools.

Special High Grade ZINC

Guaranteed 99.99+% Pure

WHEN you choose Anaconda Electric for the base of Zinc die castings, you are certain of obtaining uniform, dependable metal. For every slab of Anaconda Electric Zinc is electrolytically refined and guaranteed 99.99+% pure.

Anaconda Electric Zinc is supplied in 50 lb. slabs clearly marked "Anaconda Electric 99.99+%." Whenever you use this well-known brand, whether in small quantities or carload lots, you may be sure that *every slab will test 99.99+% pure.*

39392

Shipping Point: Great Falls or Anaconda, Montana

ANACONDA from mine to consumer

ANACONDA SALES COMPANY

25 Broadway, New York

Subsidiary of Anaconda Copper Mining Company

Zirconium-Copper Concentrate

Zirconium-copper, a new material for improving standard brasses and bronzes, is now supplied in the form of a concentrate by P. R. Mallory & Co., Inc., Indianapolis, Ind. The zirconium is claimed to not only act as a deoxidizer and scavenger of a melt, but when alloyed with manganese bronzes, aluminum bronzes, and others, it gives increased hardness and tensile strength, higher thermal and electrical conductivity, and improved corrosion resistance. Fine grain materials with clean grain boundaries result from its use. The zirconium-copper concentrate is said to have been found to be of particular advantage in producing nickel bronzes. The ductility of such alloys is substantially increased, giving greater reliability to sand cast material.

Mallory metallurgists have developed new methods of heat-treating zirconium bearing alloys to further improve their properties and make them particularly resistant to creep and oxidation at elevated temperatures. Proper melting and pouring methods have also been worked out.

Two standard concentrations, containing 12½% and 35% zirconium, are supplied. They are produced by the "Hydrimet" process which insures highest purity. The most widely used concentration is the 35% zirconium-copper which is furnished in the form of bars and lumps having a high density. The concentration will alloy immediately and without difficulty with a melt, resulting in the highest recovery of zirconium.

A Rotary Furnace

A new type of rotary furnace has been put on the market by Foundry Equipment Ltd., Linsdale Works, Leighton Buzzard, England. It is said that it may be fired with pulverized coal or with oil. A description follows:

The furnace is made in capacities from ¾ to 5½ tons. Body of the furnace is a cylindrical steel casing revolving on two rails which run on four rollers. The two rollers situated at the burner end are power driven. Pulverized fuel is stored in a hopper which has control arrangements for driving the requisite amount of fuel to the furnace by an endless belt and valve control. Amount of coal dust introduced into the furnace can be controlled at will. A fan or positive blower can be used for operation of the furnace.

The burner is of special design so that the pulverized fuel is diffused into the combustion draft. The burner is protected by a refractory face. Gases, resulting from combustion, escape through an outlet opposite the burner and enter into a chamber made of steel plate protected by refractory lining. The chamber can be pushed out of the way on a track during slagging or addition of various alloys in the furnace. The loading arrangement is attached to the furnace and it runs right into the furnace. Turning a wheel inverts the charging bucket so that its charge is deposited in the furnace. A further half-turn of the wheel brings the charger back into its original position for refilling. The furnace can be operated with oil by making certain modifications.

High Performance Solvent, Also Rust Preventative

A unique solvent that combines soap and water detergency with the high solvent performance of benzines is announced by A. F. Curran, research and development chemist for The Curran Corp., Malden, Mass. The new solvent, according to the development laboratory, is sparkling clear in appearance, highly penetrating and non-inflammable. Small metal parts, stampings, extruded shapes, or die-castings dunked in the solvent assume a scoured appearance without etching, marking or loss of weight. Such parts may be rinsed by sluicing with water to obtain perfect chemically-clean surfaces where painting or lacquering is to follow. It is said that where prevention of storage corrosion or rusting is desired, the parts need not be water rinsed, but are simply drained or centrifuged to remove excess solvent. The light phenolic-type Gunk film remaining will act, it is claimed, as a rust preventative, making an extra treatment with oil unnecessary.

Current Metallurgical Abstracts

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1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

1 Ore Concentration

Crushing, Grinding, Plant Handling, Gravity Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching

JOHN ATTWOOD, SECTION EDITOR

Primary Crushing. Summary of Field Tests. MARK SHEPPARD. *U. S. Bur. Mines Rept. of Investigations* 3432, Jan 1939, 41 pp. Research. The size distribution of products from crushing, under similar conditions of feed and discharge setting, in the Blake-type, gyratory and single-roll crushers is similar. The size that occurs in the highest percentage is that of the discharge opening; the sizes below occur in diminishing quantities. Changes in size of feed are reflected to some extent in size distribution of the product. Crushing a selected size of small lump produces a higher percentage of coarse product in the sizes near that of the crusher discharge than does the crushing of large lump. Crushing run-of-mine produces more fines than does crushing of lump. Size distribution from swing-hammer mills differed greatly from the others; max. percentage was smaller than discharge opening; changes in size distribution of feed did not cause any change in size distribution of product. The shape distribution from jaw and gyratory crushers was similar. AHE (1)

Deep Air-flotation at Britannia. NORMAN A. MACLEOD. *Trans. Can. Inst. Mining Met.*, Vol. 41 (in *Can. Mining Met. Bull.* No. 320, Dec. 1938), pp. 473-480. Descriptive. A cell 100 ft. long, 5 ft. wide, and 8 ft. deep has replaced 500 ft. of standard Forrester machines. Points in favor of deep cells are: (1) The machine is simple of design and can be assembled at the mill, (2) there are no moving parts and practically no wear or replacement, (3) the design can be adapted readily to suit various conditions, (4) initial costs are low, less than $30/ft. of length, (5) maintenance and repair costs are negligible, (6) use of 1 cell instead of many enables more economical use of reagents, (7) with higher pressures, smaller blowers and air headers are required as compared with the ordinary pneumatic cell, (8) recovery is increased, (9) very uniform results are obtained, (10) the cell is equally efficient in roughing or cleaning, (11) shut downs are due only to power failure, (12) because of positive circulation, pulp shows no tendency to choke the machine, (13) better metallurgy is possible, (14) power costs are less than for ordinary flotation cells, and (15) a minimum of floor space is used. AHE (1)

Amalgamation of Auriferous Concentrates. A. E. FLYNN. *Trans. Can. Inst. Mining Met.*, Vol. 42, (in *Can. Mining Met. Bull.* No. 323, Mar. 1939), pp. 150-163. Practical. Ball milling hardens the surface of Au particles until Hg will not dissolve them. Hg is lost by flouring, by sickening, and by chemical action. It is easily floured by any violent action, but will coalesce with proloonged washing with clean H_2O. The worst sickening is caused by foreign matter, in Nova Scotia chiefly arsenopyrite; periodic dressing of plates is necessary to remove coatings. The following minerals react with Hg (arranged in order of toxicity): Stibnite, C, enargite, realgar, tetrahedrite, pyrrhotite, marcasite, arsenopyrite, and pyrite. Tests on Au concentrates from Montague Mines are reported. Certain chemicals will greatly reduce Hg loss. A mixture of NaOH (0.7%), arsenious oxide (0.85%) and white Pb (1.5%) gave excellent results with this ore. Hg has high surface activity. The added chemicals prevent adsorption of sulphide and gangue films by being themselves adsorbed prior to addition of ore. AHE (1)

Principles of Flotation. VII. Mercaptobenzthiazole as a Flotation Agent. IAN WILLIAM WARK & KEITH LEONARD SUTHERLAND. *Mining Tech.*, Vol. 3, Feb. 1939, T.P. 1007, 12 pp. Original research. The influence of alkalies, cyanide and $CuSO_4$ on the absorption of the collector mercaptobenzthiazole (Flotagen) by the minerals galena, sphalerite, pyrite and chalcopyrite was investigated for the temperatures 10° and 35° C. The captive-bubble method was used to test absorption. In the absence of $CuSO_4$, the minerals respond to this collector in the same order that they respond to ethyl xanthate. In the presence of $CuSO_4$ there is a good differentiation between pyrite and chalcopyrite, and between pyrite and sphalerite. There is a relatively wide range of pH values over which no cyanide is required to prevent absorption of pyrite. The dependence of this pH range on the temperature, on the concentration of $CuSO_4$, and on the concentration of the collector was studied. The substitution of Cu acetate for $CuSO_4$ greatly increased the differentiation between pyrite and chalcopyrite, and between pyrite and sphalerite. Other anions and the acetate are to be investigated with ethyl xanthate. Cerussite and malachite adsorb mercaptobenzthiazole from solutions of low concentrations, provided that free alkali is not present. On the other hand, anglesite responds more readily in alkaline solutions, but relatively high concentrations are required. For Part VI, see also *Metals and Alloys*, Vol. 9, Aug. 1938, p. MA 479 L/8. JLG (1)

Some Factors Affecting the Flotation of Silver Minerals. E. S. LEAVER & J. A. WOOLF. *U. S. Bur. Mines Rept. of Investigations* 3436, Feb. 1939, 25 pp. Research. All Ag minerals tested could be floated with high recovery under proper conditions. Lime has little effect upon recovery of cerargyrite, argentite, polybasite and tetrahedrite but usually lowers grade of concentrate by coagulation of slime. Recovery of proustite, pyrargyrite and stephanite is decreased greatly by addition of lime to flotation feed. Na_2S has a pronounced detrimental effect upon recovery of Ag minerals. Cerargyrite recovery is not affected appreciably by addition of talcy or clayey Fe oxide slime to flotation feed, but grade of concentrate is lowered. Starch can be used to depress a considerable part of the slime without lowering cerargyrite recovery. Fe oxide slime lowers argentite recovery and grade of concentrate due to coating of argentite, but starch remedies the condition. Recovery of polybasite, proustite, stephanite and tetrahedrite is not lowered by presence of talcy slime in feed, but grade of concentrate is effected since a large amount of talc must be floated to obtain high Ag recovery. Starch may be used to depress talc while floating polybasite and tetrahedrite but is not successful with proustite and stephanite, which it depresses. Pyrargyrite is especially sensitive to any change of condition in the flotation circuit; talcy slime lowers recovery and grade; starch can not be used to remedy this situation since it depresses pyrargyrite. AHE (1)

Development and Practice of the Magdeburg Blend Roasting Plant (Ueber Entwicklung und Erfahrungen der Magdeburger Blenderösthütte) W. GEHRHARDT. *Metall u. Erz*, Vol. 36, No. 1, 1939, pp. 10-15; No. 2, 1939, pp. 38-43. Research and discussion. Results of tests with a Dwight-Lloyd machine showed that suction draft roasting was not as profitable with fine ore as with porous, coarse-grained ore. In addition, treatment of the product by wet metallurgical processes indicated a high Fe solubility that could be prevented only by keeping the S of the charge under 5%. Roasting of fine blend in shelved ovens is recommended. The principal characteristics of the improved mechanical roasting ovens are discussed. Fuelless roasting of blend is possible through correct transfer of the heat to the final roasting period, efficient descent roasting processes as well as by forced air roasting methods. The Balz oven and rotating oven developed by Debuch are briefly described. A complete description of the Magdeburg 9-hearth Humboldt roasting oven is given. It operates on the principle of a large surface area and a high gas velocity. The possibilities of suspension roasting are discussed. PCR (1)

The Concentration of Canadian Molybdenite Ores. W. L. TIMM & C. S. PARSONS. *Can. Dept. Mines & Resources, Bur. of Mines, Memorandum Series* No. 69, Jan. 1939, 13 pp. Review. Molybdenite ores of Canada are of 6 types. The best method for concentrating each is described. Molybdenite is one of the easiest minerals to float, and proposed methods simply introduce slight variations in a flow sheet involving crushing, grinding, classification and flotation. Pine oil is the best frother and kerosene the best collector. AHE (1)

Quicksilver Metallurgy Today. ALFRED L. RANSOME. *Eng. Mining J.*, Vol. 140, Apr. 1939, pp. 46-49. Review. The greatest advance in recent years has been made in improving the designs in use during the War period, including mechanical furnaces, dust collectors, condensing systems, and the types and grade of fuel used for firing the furnaces. Preliminary treatment in the form of concentration can be classified as: (1) hand sorting, (2) screening, alone and in combination with scrubbing, (3) jigging and (4) flotation. WHB (1)

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

2a. Ferrous

Substantial Saving Effected in Slag Removal. *Blast Furnace Steel Plant,* Vol. 27, Apr. 1939, pp. 390-391, 396. Describes Cardox method. Cartridge of high-tensile steel tube 2 in. outside diam. and 4 ft. long, is filled with 2½ lbs. of liquid CO_2 under 1000 lbs. pressure. One end is fitted with wiring mechanism, to which a standard blasting magneto is attached. The other end is sealed with a rupturable soft steel disk, which upon release allows expanding gas to come out of 4 angular port holes. Vertical holes are drilled into slag by means of a sinker drill using 2½ in. detachable bits on drill-steel. Holes must be straight and to within 6 in. of slag bottom and are usually placed on 3-4 ft. centers. Hot or cold slag can be shot with equal safety. H_2O is run into drill holes prior to and during shooting. This gives the charge a hydraulic action, widening the effective range of each shot. It is advisable to provide false walls in slag-pockets as range of action of material is increased greatly; slag can be removed quickly; greater furnace efficiencies can be obtained; as much as 50% fewer cartridges are required to break up slag; and main furnace walls are generally left in better condition. MS (2a)

The Smelting of Low-grade Iron Ores, Especially of Roasted Gutmadingen Dagger Ores (Die Verhüttung eisenarmer Erze, besonders von geröstetem Gutmadinger Daggererz) A. WILHELMI. *Stahl u. Eisen,* Vol. 59, Apr. 27, 1939, pp. 501-511. Practical. The main problem in the smelting of the low-grade Dagger ores of south Germany is the high fuel consumption required to melt the slag and drive off the CO_2 and H_2O. So far, beneficiation of the ore has not proved economical. The metallurgical recourse of using a rather acid slag and charging less limestone has saved some fuel, but the consumption is still high, about 1765 kg. of coke/ton of pig Fe. Roasting of the ores reduced this appreciably to from 350 to 1400 kg./ton. Still, the working of the furnace was not satisfactory and the yield of pig Fe was low. Using the low-grade Dagger ores, the furnace volume required for the charge and coke is about twice that with normal Rhenish-Westphalian ores. Thus, smelting of the Dagger ores must remain costly, but the nation bids them to be utilized. SE (2a)

Cooling-box Inserts of Aluminum for Blast Furnaces (Kühlkästen-Einsätze aus Aluminium für Hochöfen) W. LINICUS & H. SAUTER. *Aluminium,* Vol. 21, May 1939, pp. 388-390. Descriptive. The cooling arrangement of the entirely welded shaft of a new blast furnace consists of boxes of Al which, according to operating results, gave much more effective protection of the brick work; 24 boxes of 90-mm. height are evenly distributed on the circumference of the furnace, with 600-900 boxes required for one furnace. To avoid attack by the cooling water the inside of the boxes is protected by an MBV-layer. Ha (2a)

Equilibria in the Reduction of Silicon and Titanium in the Blast Furnace (Gesetzmässigkeiten bei der Reduktion von Silizium und Titan im Hochofen) E. FAUST. *Arch. Eisenhüttenw.,* Vol. 12, Feb. 1939, pp. 361-364. Original research. Ores containing silica and titania were smelted in the blast furnace. Analyses of the pig Fe and of the corresponding slags in 59 tappings were made. About 4 times as much of the titania was reduced to Ti in the pig Fe as of silica to Si. SE (2a)

2b. Non-Ferrous

Electrolysis: Principles of Plant Design and Operation. H. J. T. ELLINGHAM. *Trans. Inst. Chem. Engrs., London,* Vol. 16, 1938, pp. 77-96; discussion 96-103. A review of electrode reactions and the process of electrolysis, and a description of industrial practice. In the discussion, A. P. Newall describes a new process for the production of Pb and S by the electrolysis of a solution of galena in fused $PbCl_2$. Graphite or amorphous C electrodes are used and do not deteriorate, as neither O_2 nor Cl_2 is liberated at the anode surfaces. The ore, PbS concentrate, is carefully dried and then fed direct to the cell. The concn. of PbS is maintained during electrolysis at 2 to 5% of the wt. of $PbCl_2$. Minerals insoluble in the electrolyte, *e.g.* silica and zinc blende, are removed by skimming. Minerals consisting of sulphides of Ag, Sb and Bi, are dissociated; the metallic constituents enter the Pb as impurities and the S is liberated. The electrolytic cell consists of a rectangular firebrick vessel, divided into 2 compartments. S is drawn off to a condenser, and Pb removed by means of a cast iron syphon. The operation is continuous, the cell being maintained at 500 to 600° C. Over a fairly long period of operation on a semi-commercial scale, Pb of the following average analysis was produced: Ag, 6.6 oz. per ton (0.0203%); Sb, 0.029%; Zn, 0.014%; As, Fe, Cu and Bi combined 0.0086%; Pb by diff. 99.93%. MWS (2b)

Electrolytic Silver Refining. EDMUND DOWNS. *Metal Ind., London,* Vol. 54, May 19, 1939, pp. 543-546. General. The widespread demand for 99.95% (and over) quality Ag has compelled the refiner to adopt the electrolytic process. The Moebius and Balbach cells are in most general use. The Moebius cell is of greatest value when used for refinable Ag of 960-980 quality while the Balbach cell is ideal for similar or lower quality metal containing Au. The Balbach cell uses a lower current density and is better able to handle with low quality anodes, whereas the high current density of the Moebius cell is very suitable for rapid refining of high quality Ag. In both cells the current efficiency is about 95-97%. There is little to choose between the two systems in respect to cost. Both cells use an electrolyte of silver nitrate acidified with nitric acid. In the Moebius cell the deposit of fine Ag forms loosely and is readily detachable with scrapers. The Balbach cell deposits large easily detached crystals. A reducing atmosphere during melting is advisable. The advantages of the Moebius cell are of greatest value when the current consumption and output per unit area of flow space are considered. The current cost of the Balbach cell is twice that of the Moebius cell. The labor cost of the Moebius cell is higher, but in floor space this cell is more economical. RWB (2b)

Columbium and Tantalum. N. A. BELOZERSKY. *Tsvetnye Metal.,* No. 12, Dec. 1938, pp. 76-83. A brief description of the occurrence and production of Cb and Ta. Russia has 2 sources of these elements: Ilmenite-rutiles in the Urals and loparites in the Kola district. The ore deposits are enormous, but are of low grade. The ratio of Cb to Ta in the ores is from 8:1 to 20:1. The problems of Ta and Cb electroplating and the production of Ta and Cb by electrolysis are reviewed briefly. The disadvantage of the methods is that the product is in the powdered form. The author has developed a method of obtaining binary alloys containing these elements, either electrolytically or thermally. The cathode is the metal that is to be alloyed with Ta or Cb. A low melting eutectic forms on the cathode, flows off and collects on the bottom of the bath. Using this method, alloys of Ta and Cb with Fe, Ni and other metals were obtained. The author also mentions a method of reduction of pentoxide of Cb by means of Silumin waste and a method of reduction of chlorides and oxychlorides of Cb and Ta. BND (2b)

The Reduction of Beryllium Oxide (Ueber die Reducierbarkeit des Berylliumoxydes) W. KROLL. *Z. anorg. allgem. Chem.,* Vol. 240, Mar. 7, 1939, pp. 331-336. Experimental. An arrangement is described whereby BeO may be reduced in high vacuum with Ti. Powdered BeO is mixed with powdered Ti metal and pressed into a briquette which is then heated in vacuum in a BeO crucible. At 1400° C. reduction proceeds and Be vapor is condensed in sheet form in a refractory condensing cylinder mounted just above the crucible. Increasing the temperature to 1800° C. causes deposition of a gray powder, which analysis showed was a mixture of TiO and Be. Since BeO can be reduced with Ti it should certainly be possible with Zr. BeO can also be reduced by means of Ca or Mg if the process takes place in the presence of finely divided metal powder (Fe, Ni, Cu, etc.) and the reaction takes place at temperatures high enough so that the Be formed alloys with the metal. The reaction is carried out under argon and in the presence of chlorides. The sintered mass is treated with acetic acid to remove CaO and other salts and is then remelted under argon. Most suitable, with a 60% yield, is the reaction between Fe powder, BeO, and Ca. Ni-Be may thus be prepared Ca-free, but the Cu-Be produced by this method is very impure, containing considerable Ca. Mg is less suitable as a reduction agent because the insoluble MgO lowers the yield. HFK (2b)

3 Melting, Refining and Casting

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR., SECTION EDITOR

3a. Ferrous

C. H. HERTY, JR., SECTION EDITOR

Composite Rolls. F. C. T. DANIELS (Mackintosh-Hemphill Co.) *Steel,* Vol. 104, Mar. 13, 1939, pp. 63, 66. Descriptive. Composite rolls have a body shell of a hard, tough, wear-resistant, high-alloy cast iron, with body cores, necks and wobblers of a high-strength cast iron. Rolls are cast similarly to method used for chilled rolls except that metal for outer working surface is cast into mold first. It is allowed to remain in place for a predetermined length of time so it can solidify to proper depth. Then, metal for central portion is poured through mold, completely displacing all original hard Fe that has not solidified. An integral product with a perfect bond is obtained. Properties of working surfaces can be varied accurately to give best results for particular service conditions. Hardness can be varied from 65 to 95 scleroscope C to a depth of 2-4 in. per side. In use, the rolls require no additional precautions over those ordinarily required for standard rolls of equivalent hardnesses. Their use in preference to chilled rolls is justified only where severe service conditions are to be encountered. They are being used on all stands of 4-high, continuous, hot, wide-strip mills; 4-high, cold, wide-strip mills, tandem mills, skin-pass mills and cold-reduction Sn-plate mills, 2-high cold-finished sheet and Sn mills; and 2-high, cold-finishing non-ferrous mills. They have long life and low thermal expansion, maintain working surface well, and produce high grade finishes on product. Service results show that Fe rolls of a certain scleroscope hardness are equivalent to hardened steel rolls 10 points harder. Hardest grades of these composite rolls cannot be furnished with an axial hole, which has been found to be unnecessary. Rolls cannot be turned in a lathe but must be ground. In making the rolls, tension stresses between sleeve and core are avoided during cooling by having the former of a white martensitic structure and the latter of a graphitic structure containing martensitic mixed crystals in an amount corresponding to that in the sleeve structure. Core structure can be obtained from the most varied alloying elements by suitable choice and proportioning. If, for example, the sleeve consists of 3.6% C, 4.5% Mn, 2.5% Ni, 1.5% Cr, remainder Fe and the usual impurities, the core will preferably contain 3.3% C, 1.0% Mn, 3.5% Si, remainder Fe and usual impurities.

MS (3a)

Employing Photoelectric Device to Control Open-hearth Temperature. *Steel,* Vol. 104, Jan. 9, 1939, p. 49. Subsidiaries of the U. S. Steel Corp. have installed photoelectric control units on some of their open-hearth furnaces. Device is placed in walls of furnace at such an angle that only light from roof interior is reflected on it. Greater uniformity in temperature obtained has resulted in improved quality of steel, 50% longer life of refractory brick lining, and slightly shorter time required to produce a melt.

MS (3a)

The Metallographic Differentiation of Sand, Furnace, Slag and Shrinkage Defects in Cast Iron. H. MORROGH. *Bull. Brit. Cast Iron Research Assoc.,* Vol. 5, Jan. 1939, pp. 295-296. Research. Viewed under the ordinary metallurgical microscope, sand grains washed off the mold face by the movement of the molten metal and entrapped in the casting are either completely surrounded by metal or occur alongside holes. Such sand inclusions are dark gray-green in color and nearly always of the same order of size. The dark color of these sand inclusions has been noted previously by E. F. Wilson *(Trans. Am. Foundrymen's Assoc.,* Vol. 37, 1929, pp. 183-198), who presumed that they were attached to the casting by the fluxing action of iron oxide on the bond, the black appearance of the slag so formed disguising the silica. An explanation of this type seems very probable in view of what has been observed when this defect occurs in heavy castings. In heavy castings there is a tendency for a defect of this type to have the appearance, under the microscope, of a slag with a duplex structure. In such cases, care must be exercised to avoid mistaking the inclusion for an inclusion of furnace slag; the structure of slag inclusions is a dark gray-green matrix with lighter bluish needles. Usually the presence of a few areas showing the more characteristic sand grains, as in light or medium castings, settles the nature of the defect. Every effort should be made to show that none of these sand grains are present before the constituent is dubbed "furnace slag." It should be remembered that mechanically-included furnace slag is a comparatively rare defect. In most samples observed, the slag has a black appearance to the naked eye, but when examined under a microscope, it has a color greatly resembling that of manganese sulphide crystals, and usually has a duplex structure. When shrinkage cavities are fairly large, they can be recognized by the presence of dendrites jutting out into the major part of the cavity. Sometimes, however, large shrinkage cavities in gray cast irons show no such dendritic outlines, and the nature of the defect can be confirmed only by the presence of minor cavities in the metal immediately surrounding the defect. If the iron is phosphoric, tentative evidence can be obtained by studying the amount of the phosphide eutectic in the surrounding metal. When the cavities are not very large, they are nearly always characterized by their dendritic appearance. Sometimes these cavities may be filled with hyper-eutectoid graphite and sometimes they are ringed with cementite. When they occur in malleable iron, cavities may be filled with oxide. The paper is illustrated with 5 micrographs.

AIK (3a)

The Reactions of High-carbon Iron-manganese Melts with Iron Oxides, Iron Sulphide and Silicates at 1300° to 1400° C. Laboratory Experiments to Obtain Manganese-rich Slags (Die Umsetzungen hochkohlenstoffhaltiger Eisen-Mangan-Schmelzen Mit Eisenoxyden, Eisensulfid und Silikaten bei 1300°-1400°. Laboratoriumsversuche zur Gewinnung manganreicher Schlacken) W. OELSEN. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf* Vol. 21, No. 5, 1939, pp. 79-104. Research, chiefly on the reactions with only small amounts of oxides and sulphide. The composition of the slags is determined by the final Mn content of the Fe. As long as it is more than about 1% Mn, the slags consist largely of MnS and MnO and contain very little FeO and FeS, so that these slags can, after roasting, be used for preparing high-Mn ferromanganese. The S contents of the Fe melt after the reaction are determined by the residual Fe content of the slags and increase practically in proportion with the Fe content. If SiO_2 gets into slags with about 50% MnS and 50% MnO over Mn-poor Fe melts (less than 1% Mn), considerable S is forced into the Fe melt; SiO_2 causes a tendency for the slags to separate into a sulphide-rich and a silicate-rich zone. Mn-rich slags with 22-28% SiO_2 and 50-58% Mn are very liquid in the range from 1350°-1420°, so that the oxidation of the Mn in the spiegel can be effected by iron oxides alone without sulphides. This is of importance for the production of high-Si spiegel Fe in the blast-furnace. When oxidizing Mn from P spiegel by FeO-FeS mixtures, appreciable amounts of P go into the slag, but higher S and SiO_2 contents of the slag retard P oxidation. The ratio Mn/Fe in the slag becomes more favorable if the Mn oxidation is not made in one, but in several stages; this reduces also the slagging of P. Besides iron oxides, FeS, iron silicates and their mixtures, $CaSO_4$, Na_2SO_4 and iron sulphates are strong oxidizers for Mn in spiegel; phosphates are also oxidizing, but to a lesser degree. 27 references. Ha (3a)

The Acid Bessemer Process of Steel Making. T. SWINDEN & F. CAWLEY. *Iron Steel,* Vol. 12, Apr. 1939, pp. 387-391. Review and history of the process as it developed in England. The authors discuss the principles, features, and function of the mixer as well as the converter, and present a clear picture of the visual means employed by the operator in controlling composition and temperature. No instruments are needed, the products of combustion showing accurately the progress of the heat by affecting the color, character and length of flame issuing from the nose. Curves are included showing the progressive elimination of C, Si and Mn, and the pickup of the gases H, N and O.

HFT (3a)

Molybdenum in Cast Iron. W. F. CHUBB. *Foundry Trade J.*, Vol. 60, Mar. 30, 1939, pp. 274-277. Up-to-date review. There are several forms in which Mo is available: Mo metal, ferro-Mo, Ca molybdate, molyte. The pure metal is not suitable for direct addition to cast iron. Other forms satisfy many requirements as addition agents. In the cupola, high recoveries are only possible when the cupola is reserved solely for producing Mo irons. If more than one type of iron is being made, those castings required to contain Mo should be made from the first few tappings. Both ferro-Mo and Ca-molybdate can be used in the cupola, the latter being added with each charge of coke and preferably by adding it as briquettes in order to avoid loss owing to the formation of dust. Ferro-Mo is usually added to the spout or ladle, but when Ca molybdate is added in this way, time is necessary for reduction to Mo to take place at the lower temperature there prevailing. The recovery of Mo when Ca molybdate is added to the ladle is not so high as when it is added to the charge. For the air furnace, Ca molybdate and molyte can be added, but complete reduction to metal requires time. In the electric-furnace method of producing cast iron, both ferromolybdenum and Ca molybdate are permissible. For ladle additions, the best agent for adding Mo would be a Mo-Fe alloy of low melting point which can be obtained by the use of high C contents, high Si, or by reducing the Mo content to 40%. At the latter composition, the melting point is 1440° C. There is a growing tendency for users to adopt Mo pig-iron in preference to the other forms of Mo. There are 2 grades of Mo pig-iron available: (1) T.C., 3.0 max.; Si, 1.5-2.0; Mn, 0.8-1.0; S, 0.07 max.; P as required; and Mo, 1.0-5%. This is a refined Mo pig-iron available as sand-cast or machine-cast pigs. (2) T.C., 3.5 max.; Si, 1.5-2.0; Mn, 0.8-1.0; S, 0.07 max.; P, as required; and Mo, 1.0-5.0%. This is refined all-mine Mo pig-iron. The metallographic influence of Mo on Fe-C alloys is as follows: Eutectic temperature is approximately the same as in pure Fe-C alloys, namely 1130° C. The percentage of C in the eutectic is not altered appreciably. The percentage of C in the eutectoid is lowered by Mo, the decrease being 20 points for each 1% of Mo present. A new phase appears, a double carbide above and below the eutectoid transformation. No graphite appears in the usual practice in Fe-C-Mo alloys at C contents below the eutectoid concentration. Mo tends to stabilize the carbides and, therefore, to prevent graphitization. Mo has a refining action on the graphite. Heat treatment properties, Ni-Mo irons and Cr-Mo are also discussed.
AIK (3a)

The **Laws of Cupola Melting** (Die Gesetze des Kupolofenschmelzens) H. JUNGBLUTH. *Giesserei*, Vol. 26, Mar. 10, 1939, pp. 113-120. The melting process in a cupola furnace is theoretically discussed, particularly the factors determining the relation between quantity of air, charge of coke and melting capacity. The efficiency of the process can best be expressed by the ratio $\eta_v = (CO_2/CO_2 + CO) \times 100$, in the combustion gases. The melting capacity, S, can then be expressed by $S = 60000\ W/K \times C \times 4.45\ (100 + \eta_v)$, where K = kg. coke/100 kg. Fe, C = kg. C/100 kg. coke and W = quantity of air in m.^{3}/min. The discussion of this formula shows that it can be considered as a basic constant for the performance of a cupola furnace; a curve is given for average conditions of operation, but for special conditions it should always be calculated. Questions connected with combustion processes and Fe temperature, however, cannot yet be determined mathematically.
Ha (3a)

The Influence of Composition and Casting Conditions upon the Fine Forms of Graphite and the Structure of Cast Iron. ICHIRO IITAKA. *Sci. Papers Inst. Phys. Chem. Research, Tokyo*, Vol. 35, Mar. 1, 1939, *Abstract Suppl.*, p. 13. In English. Original research. The graphite contained in cast iron is divided into 5 forms: Eutectic, flake, lump, rosette and octopus-like graphite. Their formation was studied in relation to melting temperature, ingot size, Si and C content. The eutectic graphite is formed when the melting temperature and C content are high and Si content low. The formation of rosette graphite is favored by high C content and rapid cooling. The octopus-like graphite is formed with high C-content. The growth of flake and lump graphite is favored by low melting temperatures and higher percentages of C. Ferrite is formed with low Si and C contents. (See also *Metals and Alloys* Vol. 10, Apr. 1939, p. MA 225 R/6.)
EF (3a)

Evaluating the Operating Conditions of a Cupola (Die Beurteilung der Betriebsbedingungen eines Kupolofens) H. JUNGBLUTH & F. STÄBLEIN. *Tech. Mitt. Krupp*, Vol. 7, Apr. 1939, pp. 41-43. Practical. The question whether a high coke charge in a cupola furnace is an advantage or disadvantage is discussed, keeping in mind that ordinarily the thermal efficiency (*i.e.* the ratio of the heat absorbed in the Fe to the total heat produced) is the factor determining the quality of the cupola process. A closer investigation shows, however, that this is not a good basis for rating operations, for although the "efficiency" drops with increasing coke charge, the Fe temperature actually increases and the yield is increased. The relation between Fe temperature, melting capacity, amount of blast, coke charge and time of a charge is studied and expressed in diagrams.
Ha (3a)

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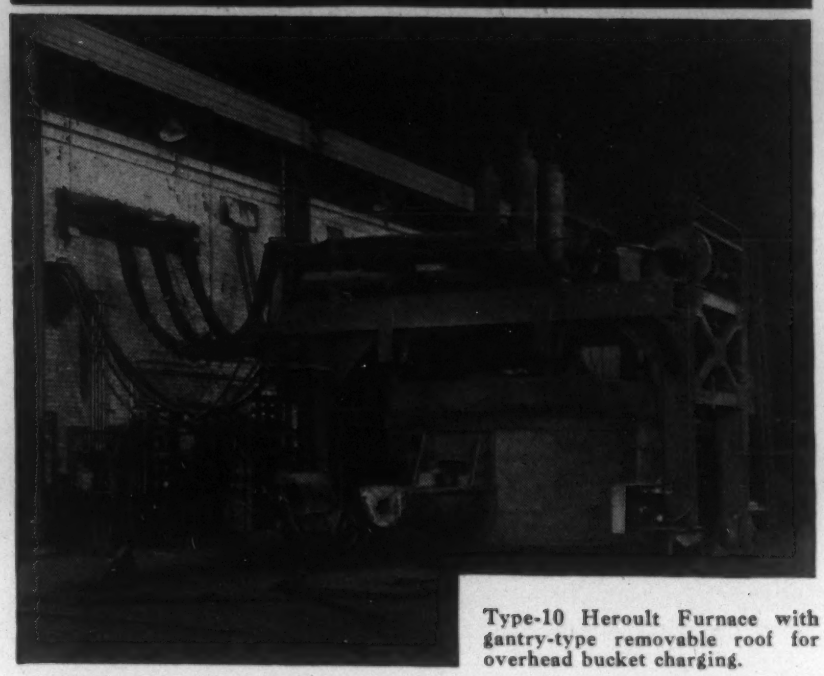

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UNITED STATES STEEL

A New Steelmaking Process. VINCENT C. FAULKNER. *Foundry Trade J.*, Vol. 60, Mar. 23, 1939, pp. 248-250. Descriptive. The first large-scale attempt to manufacture steel in a rotary furnace fired by pulverized fuel is believed to have been made at the Mons Steel Foundry in Belgium. Later the London, Midland & Scottish Railway pioneered the process that proved to be a really sound technical and commercial success. The plant, installed at Crewe, consists of two 5-ton capacity Sesci furnaces. The furnace utilizes pulverized anthracite after the recuperators, which are an essential part of the system, reach a predetermined temperature as shown by the temperature of the air used for combustion. In commencing the first heat of the day, bituminous coal only is fed into the pipe line, but when the preheated air reaches about 100° C., a small proportion of anthracite is introduced, the bituminous coal being reduced by a similar amount. The process of increasing the anthracite while reducing the bituminous coal is continued until only the anthracite is used, the indicator for the preheated air showing a temperature of about 250° C. The rotating speed of the furnace body is about one complete revolution per minute. The body is provided with 2 tapholes centrally situated. The furnaces are machine-charged by exactly the same system used in a modern open-hearth plant. The fuel is pulverized, the fineness for the bituminous being 85% through a 200 mesh B. S. sieve, and for the anthracite 99.3% to pass a 120 mesh B. S. sieve. The burner is of the standard Sesci type, and has created no difficulties since the plant was put into operation in 1935. The charge is worked down as in most steel-making processes. Here a wide field presents itself, involving the potentialities of flame conditions, the working down of high carbin charges so as to make use of exothermic reactions, etc. The C reduction is something of the order of 0.15%, usually accomplished without any iron-ore additions. This system, while not making any great use of exothermic reaction, does help to ensure a cleaner steel. An Izod impact valve of 35-40 ft. lbs. is obtained on steel castings, with a tensile of 35-40 tons/in.^{2}, by controlling the grain size through the addition of a predetermined amount of Al as the deoxidized metal flows from the ladle to the mold. The process is acid. The S and P of the scrap have to be kept below 0.05%, and there is a S pick-up of 0.012% to be taken into consideration. The next step indicated in the development of pulverized-fuel rotary furnaces is the utilization of a basic lining. Layout of the Crewe Works Steel Foundry is given. Preparation of the lining, operating details, fettling the hearth, etc., are discussed.
AIK (3a)

Desulphurization of Pig Iron by Alkalies. I. The Reactions of Sulphur-containing, Low-silicon and Low-manganese Pig Iron Melts with Soda and Sodium Silicates (Die Entschwefelung des Roheisens mit Alkalien. I. Die Umsetzungen Schwefelhaltiger, Silizium- und Manganarmer Roheisenschmelzen mit Soda und Natriumsilikaten) W. OELSEN & W. MIDDEL. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch, Düsseldorf,* Vol. 21, No. 2, 1939, pp. 27-55. Research. The desulphurizing of iron melts by soda is increasingly employed; a comprehensive study of the efficacy and limits of this method to gain a secure basis for its practical application. The experiments were made in the temperature range 1300°-1400° C. The results are summarized as follows: Soda alone, in absence of SiO_2 or Si, is a very strong desulphurizer. Laboratory tests gave even a 3 times stronger effect for soda alone than obtained in normal practice. With 0.008% S in the finished Fe, 1 kg. pure soda can remove 0.32 kg. S, and with a final content of 0.080-0.087% S, it can remove 0.44 kg. S. The sodium sulphide formed is perfectly stable in the Fe melt at 1300°-1400° and does not require any flux (sodium silicate). A slag of over 80% Na_2S and about 40% S was found over an Fe melt with only 0.008% S. This Na_2S dissolves FeS very eagerly from the melt, and permits the removal, in the absence of SiO_2 or Si, of much higher amounts of S than correspond to the stoichiometric conversion of soda to Na_2S. The slags formed in the desulphurization of Si-free Fe with soda are very liquid and contain very little FeO. The C contained in the pig iron is a sufficiently strong reducer for the FeO formed in the slag, so that no other reducing agents (Si or Mn) are required for the soda. A most intimate contact of soda with the S containing melt is advisable to form Na_2S; an appreciable reduction of the soda to metallic Na begins only after the S content has been reduced to less than 0.05%, *i.e.* when the melt is practically S-free. Strong development of smoke is an external indication that desulphurization is complete. SiO_2 depresses the desulphurizing action of soda, with respect to both the final minimum S content obtained, and the amount of S that can be removed per unit weight of soda. Sodium silicate is, however, a good desulphurizer; it can absorb about 5% S at a final S content in the Fe of 0.05% and about 8% S at 0.1% final S in the Fe. To obtain low final S contents, the procedure used in adding soda is important, especially the ratio of $Na_2O : SiO_2$. The desulphurizing action of silicates depends largely on the temperature; increase of temperature from 1200° to 1500° C. (for the same initial S content) increases the final S to about twice the amount, and the ratio $(S_{Na}) : (S_{Fe})$ to 4-5 times. The tests are described with curves and tables, and their application under practical conditions is discussed. 24 references. Ha (3a)

Melting Practice in a Large Engineering Iron Foundry. W. W. BRAIDWOOD. *Foundry Trade J.,* Vol. 60, Mar. 16, 1939, pp. 231-234; Mar. 23, 1939, pp. 253-255, 258. Practical. The foundry described produces castings for steam plants and general engineering purposes. The melting plant comprises 4 cupolas, each with a capacity of 9-10 tons/hr. Underlying principles of the balanced blast, fettling, receiver practice, slag removal and disposal, air supply, charging, cycle of charging operations, the charging routine, transport of molten metal, technical control of the foundry product, etc. are discussed. In the older type of cupola, the CO formed was left free to pass up through the preheating zone, and into the stack. The principal aim of the balanced-blast design is the complete combustion, within the cupola, of this inevitably-formed monoxide, with consequent improvement in the thermal efficiency of the furnace; this is effected by the introduction, above the producer zone, of sufficient air to burn the CO to CO_2. There can be no doubt that the balanced-blast system constitutes a definite advance in cupola design, and, with intelligent control, its economic potentialities are considerable. The efficiency of a cupola is generally measured in terms of the temperature of the tapped metal. A recent investigation of the effect of operating a balanced-blast cupola with various tuyere settings revealed that improvement in the efficiency of the process of combustion, as indicated by exhaust gas analysis, was not necessarily accompanied by increase in the temperature of the tapped metal. In fact, there was no direct relation between combustion efficiency and metal temperature, and, in addition, when conditions were such as to maintain a deep bed of highly incandescent coke, the highest metal temperatures were obtained. The prime factors determining the temperature of metal tapped from a cupola are "bed temperature' and "time of exposure." Therefore, where a relatively deep bed is maintained the temperature of each metal droplet, by reason of the longer time of exposure to high temperature conditions, is more able to approach that of the heating medium. AIK (3a)

The Manufacture of Rimming Steels. T. GREY-DAVIES. *Sheet Metal Ind.,* Vol. 13, Apr. 1939, pp. 483-484, 490. Descriptive. Successful manufacture of rimming steel is largely dependent on close control of oxidation of bath; consistency of quality depends on consistency in FeO of finishing slags. Late additions of ore may lead to false figures for oxide content of bath and slag. The problem of keeping down FeO content of slag with low-C rimming steel is not easy. One way is to add SiO_2, as slag oxidation is almost a direct function of the CaO/SiO_2 ratio, but free SiO_2 may erode hearth. Furnace atmosphere is also important, but has less effect on FeO of high SiO_2 slag than on low SiO_2 slag. Most English pig Fe has 1-2% P and 0.06% S, so high SiO_2 slags cannot be used because basic slags are needed for reducing P and S. One successful control method is the addition of small amounts of silicomanganese (70-75% Mn, 14-20% Si) to give about 0.04-0.05% Si in the bath. After the inclusions have been allowed to coalesce and rise, subsequent additions of Fe-Mn must be made. The bath must then be reoxidized to allow a proper boil. In about 6 min., the bath is tapped as usual. The final Fe-Mn may be added in the ladle. JZB (3a)

Investigation of Some Relationships Between Variables of the Cupola. M. M. BARIGOZZI. *Foundry Trade J.,* Vol. 60, Feb. 23, 1939, pp. 171, 172, 186. Original research. From a questionnaire made in 1936, data were obtained on the construction and operation of nearly 100 cupolas in service in Italy. For each installation, the internal diameter was ascertained, together with the coke charge, the height of the coke bed formed by the charge, assuming a specific gravity for the coke of 450 kg./in.^{3} under these conditions; the charge of pig-iron corresponding to the charge of coke; the proportion of coke to pig-iron expressed as a percentage; the quantity of molten cast iron delivered by the furnace per hr.; the quantity of blast per sec.; the static pressure of the blast in the wind-belt; and the height of the bed of coke, ignoring the first coke charge. According to the relationships that have appeared in various forms in the technical literature, equations for the coke consumption per sec. are given. It was concluded that the characteristic feature of one class of run was that the value of the blast (air weight per sec./internal area) was less than 10 times the weight of coke burnt in unit time. In a second class, on the contrary, the blast values were equal to, or greater than, 10 times the weight of coke burnt in unit time. The fact that the majority of runs observed arranged themselves in 2 types is explained by the existence of 2 main schools of foundrymen: Those who aim at economic operation, and those who subordinate this factor and keep in view only the high temperature of the cast iron. Each adept of 1 of the 2 opposite principles endeavors to cause the different factors to combine to form a certain result. In order of importance, these factors are the following: The height of the bed of coke of the charge, the ratio of the charge of metal to that of coke, the pressure and the height of the coke column. These factors are discussed at length and examples are given. AIK (3a)

An Electric Furnace for the Production of Precision Piston Rings (Le Four Électrique Appliqué à la Fabrication des Segments de Precision) M. JOLY. *Electricité,* Vol. 23, Jan. 1939, pp. 5-6. Descriptive. Piston rings are used today in increasing number and subjected to increasing wear. A furnace is described that obtains the desired composition uniformly, and in constant operation. It is the Fenwick rocking furnace of the Société Mancelle de Fonderie: Capacity 250-300 kg. metal, 175 kv.-amps., a.c. single phase; graphite electrodes and graphite lining. The furnace operates approximately 120 hr. per week, with 85-90 tappings, owing to the very short replacement time for electrodes and pieces of the lining. Dimensions of electrodes are: 1 m. long, 50 mm. outside diameter, 25 mm. inside diameter (hollow), 2.32 kg. a piece; power factor is 0.97-0.99. The rocking of the furnace is started after 20 min., when the metal becomes pasty, and continues through 35-40 min. until the metal is ready to be tapped. Using 2 furnaces, 7-8 metric tons per day are produced. Changes in analysis are: C ± 0.02%, Si ± 0.03% max.; power consumption is 610 kw.-hr./metric ton, electrode and lining consumption 2.32 kg./ton. JMN (3a)

3b. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Non-ferrous Foundry Practice. XXIII and XXIV. The Aluminum Alloys. J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 54, May 12, 1939, pp. 507-512; May 19, 1939, pp. 535-538. Practical. In the Zn group there is only one important alloy, 12.5-14.5% Zn, 2.5-3.0% Cu, remainder Al. At 440° C., Zn is completely soluble in Al up to 70% forming the γ constituent, and up to 17% at room temperature. A cored structure appears in the cast alloy, which is converted to the normal solid solution structure by annealing. The microstructure of this alloy at equilibrium consists of γ solid solution with areas of darker $CuAl_2$. For optimum mechanical properties a very narrow pouring range of 690-710° C. must be used. Unless the melt is quietly stirred just prior to pouring the Zn may concentrate at the bottom. Al alloys with 7-12% Cu are composed primarily of Al solid solution with $CuAl_2$. All these alloys contain some Fe, which is insoluble at room temperature, so that an Al-$FeAl_3$ eutectic is present. With Si present, Fe occurs both as $FeAl_3$ and in solid solution with Si and Al. The brittleness of $CuAl_2$ accounts for the poor ductility

of the 7 and 12% Cu alloys. With these alloys, fracture nearly always occurs in the eutectic network. The continuity of this network is broken by Fe, so that the path of rupture is extended and the strength increased. Fe in excess of 1% increases shrinkage and porosity. 1% Fe and 0.5% Mg increases the castability. The use of Mn increases brittleness and seriously reduces heat conductivity. 2-4% Si increases fluidity, reduces shrinkage and the tendency to hot shortness. Although such castings are sound they also are susceptible to cracking because of the contraction stresses. Alloys containing 5% Cu, or less, are responsive to heat treatment. The presence of Mg and Si gives rise to the Mg_2Si age-hardening effect. Heat treatment is applied not only to low-Cu alloys but to a large number of other alloys. The treatments may be grouped as (a) high temperature solution treatment and quench; (b) high temperature solution treatment, quench and age at room temperatures; (c) high temperature solution treatment, quench and low temperature age; (d) low temperature precipitation treatment. Types (a), (b) and (c) are readily applicable to smaller simple castings but may lead to severe damage with larger and more intricate ones. Improvement produced by treatment (a) arises from existence of hardening constituents in solid solution, by (b) and (c) from age hardening, and by (d) from removal of casting stresses. The double treatment in (b) and (c) reduces corrosion resistance. A valuable group of low-Cu Al alloys of high strength and good ductility, very suitable for the more severely stressed parts, contain 4-5% Cu with controlled amounts of Si and Fe. These alloys are responsive to both the double and single heat treatments but are not age-hardenable at room temperatures; the addition of Mg makes them responsive at room temperatures. The age-hardening of these alloys at high temperature is attributed to precipitation of both Mg_2SI and $CuAl_2$. Fe suppresses room temperature aging, but Mg restores this property. 13 references. For parts XIX-XXII see *Metals and Alloys,* Vol. 10, July 1939, p. MA 406 R 1. RWB (3b)

Designing for Die-casting. Advantages and Limitations of the Process. ARTHUR STREET. *Metal, Ind., London,* Vol. 54, Jan. 27, 1939, pp. 131-134; Feb. 10, 1939, pp. 185-188; Feb. 24, 1939, pp. 247-250. Practical designing aspects. To obtain maximum value from die-castings, it is necessary that ordinary design be modified or completely changed to meet the needs and limitations of the process. The number of parts of an assembly may be materially reduced by utilizing die castings. If a single die casting is desired, the part can be more easily and cheaply produced by assembling several die cast parts. An example of the latter case is the familiar automobile radiator grilles. The three principles in die casting design are: The die must open and close, the core must be capable of insertion and withdrawal, and the casting must be run and vented. If the casting is not so shaped to ensure its remaining on the moving die block to facilitate ejection, the design must be altered to enable the casting to contract on the moving die block. In most cases the parting plane lies at right angles to the opening axis and from the point of view of die construction this is the simplest and most usual procedure, sometimes, however, the parting has to be curved or irregular so as to conform with the largest area of the die casting. The parting line should be so arranged so as not to affect the appearance of the casting but to facilitate ease in removal. Every time the liquid alloy is injected into the mold a considerable bursting pressure is set up and one of the chief problems confronting the die caster is to provide adequate holding pressure to prevent the die from springing and the cores from being displaced. Cored holes should not enter from too many directions. A higher degree of accuracy can be achieved if the cores producing large recesses exist as an inherent part of the moving die block. Die castings can embody holes of practically any form. Allowance should be made for taper in all cored holes. The draft should be decided only after consideration of length, diameter and rigidity. Short holes can be cast without taper but a series of slender holes in different directions will need a taper of 0.005 in. or more. Inadequate taper is likely to strain the skin of the steel core and eventually cause curling, owing to the unequal stress set up. Long cored holes should be stepped. In general long holes should be cast open ended. Holes on the parting line require an overhang housing on the side of the die to support the core movement. If possible the position of the hole should be moved or the design modified so that the parting line takes a different course. Crossing cores should be avoided, where necessary the major core pin should be embodied as part of the moving block and the other core pin should not be more than half the diameter of the larger, the smaller core being withdrawn first. In any case cross coring is applied only in die castings of Sn, Pb and Zn base alloys; the high shrinkage and casting temperatures involved in the Al and brasses makes the procedure too dangerous to be practical. Where undercuts are required, straight-line core withdrawal is prevented and special core-withdrawal means must be adopted. In gravity die casting, a considerable amount of core manipulation is possible. When collapsing cores are required (for example, in the production of an automobile piston), it is best to use gravity die casting. One factor that must be considered is that of ruling section. In all cases, changes of section or direction should be amply filleted and sharp corners avoided wherever possible. For Zn- and Al-base alloys the most workable ruling section lies between 1/16 and 3/16 in. but particularly for Zn base alloys the section may be reduced to 1/32 in. or less if the die casting is small. Usually it is not difficult to recess the die casting so as to even up the section. This procedure lightens the castings, reduces raw material cost and promotes die life by breaking up hot masses of metal. A pressure casting is usually ejected by a series of ejector pins which operate on an unimportant face, and operate best at right angles to the face of the casting. When lettering is used it is best arranged perpendicular to the axis of the machine. The use of multiple dies when possible is recommended, but should not be carried to excess. Special properties may be required so that an insert of different material has to be cast into the die-casting. The insert is located in the die in such a manner that the alloy will solidify around it, gripping it tightly. The part which is cast-in must be of such accuracy that it will fit into the die without any play, and held in such a manner that the incoming metal will not displace it. The insert should be knurled or threaded so that the die cast metal will grip it and prevent it from being withdrawn or rotated. There is practically no limit to the types of material that may be used as inserts in die-castings. RWB (3b)

The Casting of Bearings by the Centrifugal Casting Process (Das Ausgiessen von Lagern nach dem Schleudergussverfahren) A. MECKEL. *Metallwirtschaft,* Vol. 18, Apr. 14, 1939, pp. 321-323. Descriptive. Apparatus for the centrifugal casting of bearings is briefly described. This process will give a fine grained, dense casting, especially if the backer is water cooled while pouring the bearing. The centrifugally cast bearing has a different structure than found in hand cast bearings. The latter show a uniform distribution of Sb-Sn compound in a Pb-rich matrix; in the centrifugally cast bearing the Sb-Sn crystals, being lighter, are concentrated at the bearing surface while the heavier Pb-rich matrix is concentrated at the backing shell. Thus, the centrifugally cast bearing has a wear-resistant running surface with good bearing characteristics, while at the steel backer the Pb-rich matrix possesses the requisite toughness. Very little machining is needed to prepare the bearing for use and should not amount to more than 30% of the original thickness of the casting. The following relation between speed of rotation and bearing diameter has been found to give satisfactory bearings: R.P.M. = 1600/r, where r is the radius of the bearing in centimeters. GA (3b)

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4 Working

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S. EPSTEIN, A. W. DEMMLER

AND H. W. GRAHAM,

SECTION EDITORS

The Practical Importance of the Theory of the Rolling Process (Ueber die praktische Bedeutung einiger Erkenntnisse der Theorie des Walzvorganges) THEODOR DAHL. *Kalt-walz-welt,* Mar. 1939, pp. 17-23; Apr. 1939, pp. 25-32. The relative displacement and the effect of the forces in the rolling gap as well as the importance of rolling friction in the rolling process are considered. The coefficient of friction μ during rolling depends on many factors, which are permanently changing during the course of rolling, particularly the surface condition, temperature and surface moisture of roll and product rolled. Therefore a definite coefficient of friction must be applied cautiously. The coefficient of friction is important, however, as it affects the arrangement of the drive and rolling stands. The average μ amounts to about 0.4 with hot rolling and 0.1 with cold rolling. Since friction is the means of power transmission with the rolling process, a certain amount of friction is required. When friction becomes too large, the resistance to metal flow also becomes too large. Besides bringing about increased power consumption, a large resistance to flow also unfavorably affects the extension of the product rolled and the stress distribution. Since the resistance to flow can be affected arbitrarily to a certain extent, it is the natural aim to decrease the resistance to flow. From these considerations it can be concluded that rolling methods aiming at a decrease of the resistance to flow by diminishing the coefficient of friction, or a decrease of rolling diameter, or application of a longitudinal tension will be further developed. To a large extent, these factors have been considered in the design of the modern strip mill. 22 references. GN (E-4)

The Plastic Flow of Metals. C. W. MACGREGOR (Mass. Inst. Tech.) *Metals Tech.,* Vol. 6, Apr. 1939, 17 pp. Original research. In order to reveal plastic flow in the form of Lüder's lines, which appear on the highly polished surfaces of mild steel when stressed above the yield point, a new special optical bench was designed, using a system of reflected light. The equipment is so designed that it is possible to use it for: (1) Projection of the image of tested specimens on a class or lecture-room screen to a large magnification; (2) taking still photographs at small or large magnifications, revealing the plastic flow on a test piece continuously as it occurs during testing by easily moving the equipment to the testing machine and observing the image on a ground glass; (3) showing the plastic flow in such processes as the rolling of metals; and (4) taking motion pictures of the plastic flow. Motion pictures were made of the yielding in test pieces stressed in compression in the form of disks with and without holes, rectangular bars with and without holes, and rectangular bars with notches. Also, films were made recording the flow in butt and lap welds, bars undergoing double shear, and in a bar as it was passed through a rolling mill. JLG (D-4)

Conditioning Mill Rolls. H. J. WILLS (Carborundum Mfg. Co.) *Steel,* Vol. 104, Feb. 13, 1939, pp. 48-49, 74-75. Practical description of proper procedure in finishing roll surfaces. Gives details on speed, feed, type of wheel and methods used, with typical examples. To secure proper penetration of grains into work, several narrow wheels instead of one wide one are recommended, because power consumption is reduced and additional cutting edges are procured. In general, silicon carbide wheels are used to produce high luster and aluminum oxide wheels for satin finish. Best wheels to use are: For hot mill rolls, wheels 20 to 3 grit, one diamond dressing per roll; for cold mill rolls, wheels 8 to 180 grit, 1.2 diamond dressing per roll; and for ultra-finish rolls, wheels 220 to 800 grit, one diamond dressing per roll. To prevent chipping by dressing tool and traverse work, which will harm surface of roll, wheel finer than 60 grit should be rounded at the edges, both before and after dressing. The faster the work speed, the better the roll surface. It is important to keep point of contact between roll neck and neck-rest well lubricated. VSP (E-4)

The Machinability of Metals. O. W. BOSTON (Univ. Mich.) *Modern Mach. Shop,* Vol. 11, May 1939, pp. 74-88. Survey. The essential factors of machinability of a metal are discussed at great length from the point of view of tool life, energy required to perform the machining operation, forces involved, cutability as measured by the tool penetration under pressure, quality of surface, and cost of removal of the metal. Diagrams of tool life under various machining conditions and tables giving depth of cut and feeding speed, and tool life/in.^{3} grind for machining wet (with different cutting fluids) and dry are added. Ha (G-4)

4a. Ferrous

Recommendations for Working Stainless. *Steel,* Vol. 104, Mar. 6, 1939, pp. 48-49, 52, 81-82. Practical. Presents best practice, according to the Republic Steel Corp., in rolling molded sections, forging, annealing, pickling and cleaning after fabrication and erection. In rolling molded sections, forming rolls of a case-hardening type of steel, SAE 1020 or a low-C alloy, turned to required form and hardened are used by most manufacturers. Sharp edge roll should not be used. Where molding is subjected to considerable side friction, insert of hard alloyed bronze or full section bronze roll is of great help. Roller guides are preferred to those of stationary or friction type. Lubrication of surface of material is most important. Same types of lubricants recommended for drawing can be applied. In forging 18-8 variety, heating should be done carefully in a clean furnace that is long enough to permit placing parts well back in it. Heating should be slow up to 1500°-1600° F., followed by thorough soaking at this temperature, then brought up rapidly to as near 2150° F. as possible. First few blows should be given rather lightly. Little work should be done at 1850° F., with 1800° F. the minimum. It may be necessary to reheat several times but this is not detrimental unless the steel is allowed to soak at high temperature. Time required for heating bars is about that necessary for C steel, and amount of blows upward of 25% greater for a given amount of working. Dies in which it is necessary to gather stock in breakdown should be constructed so that the metal flow will be outward. Dies should be designed to make the least possible amount of flash. Small drop forgings can be dropped into H_2O when they come from the die, which helps to break up scale and simplifies pickling. For forging straight-Cr steels, the above applies in general, except that forging temperature differs slightly. Temperature range for drop forgings should be 1900°-2000° F. For grades approaching cutlery type, temperature should be lowered to about that of tool-steel requirements, with 1750° F. lowest. After fabrication, material is washed first with a good solvent, wiped dry, and then treated with finely bolted whiting sifted on the surface and wiped off with a soft cloth. Material for buildings may be protected by heavy kraft paper applied with ordinary paperhanger paste, that can be washed off with warm H_2O. If not thus protected, surface should first be washed with a suitable solvent. Final washing follows, using half-and-half powdered 00 pumice and whiting on a soft rag, wet with plain H_2O or H_2O containing a little NH_4OH. Excess powder is removed with clean, wet rag, and remainder allowed to dry and wiped off with a soft, dry cloth. This is satisfactory for No. 4 and 6 finishes. For No. 7 and 8 finishes, only NH_4OH and whiting or only dry whiting should be used. Mechanical cleaning should never be used. MS (D-4a)

A New Era in Continuous Rolling. *Sheet Metal Ind.,* Vol. 13, May 1939, pp. 611-622. General description of the Ebbw Vale mill, which is the first continuous hot and cold strip mill in England. **Under the Surface at Ebbw Vale.** T. J. KAUFFELD (Inter Continental Engr. Co.) *Sheet Metal Ind.,* Vol. 13, May 1939, pp. 623-630. More detailed description of centralized pressure oil lubrication, pressure grease lubrication, hydraulic descaling, roll contour control, internal roll cooling and palm oil distribution system. JZB (E-4a)

Hot-rolling Experiments on One Carbon Steel and Three Alloy Steels (Warmwalzversuche an einem Kohlenstoffstahl und drei legierten Stählen) A. POMP & W. LUEG. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 21, No. 10, 1939, pp. 171-180. Research. Four different steels were rolled in a temperature range from 700° to 1200° C. to determine the effect of the reduction and roll temperature on rolling pressure, deformation resistance and rolling capacity. "Advance" and spreading were largely influenced by the reduction of the pass; the rolling temperature had much less effect. The composition of the steel was found to be of no importance, except for a high-alloy rustless cutlery steel, where roll pressure and average deformation resistance—and also the rolling energy—were much higher. "Advance" and spreading are not influenced by composition. Ha (E-4a)

4b. Non-Ferrous

Cold drawing Brass Rod. MAURICE COOK & G. K. DUDDRIDGE. *Metal Ind., London,* Vol. 54, Mar. 17, 1939, pp. 321-324; Mar. 24, 1939, pp. 343-346. Research. The results of a detailed study of the hardness and tensile strength distribution over the cross section of a typical drawn brass and Mn-bronze rods are described. Although rolled sheet metal has extremely small differences in hardness between the skin and center of the cross section, this difference is considerable in cold drawn rod. Tensile tests of a full cross section give no indication of the distribution of the strength over the section. The material studied was taken from work passing at the time through an extrusion mill, and included small diameter 60:40 rod, free turning brass and large diameter rods of 60:40 and leaded medium tensile brass. Hardness determinations were carried out on surfaces prepared parallel to the axes of the rods and by progressive removal of the metal by filing and polishing. Filing caused work hardening of the surface to the depth of 0.003-0.004 in., but polishing with emery paper produced but a very slight hardening effect. In as-extruded rods, the variation in hardness and tensile properties over the cross section was negligible. In all drawn rods, the minimum hardness is at the center, and it increases, at first slowly, and then more rapidly as the surface is approached. In ½-in. rods, the hardness differs from 10 to 20 Vickers hardness numbers from center to surface. A hardness variation of about 50 Vickers was found to 2-in. diameter rods. For tensile tests, the rods were reduced by machining. The amount removed at each stage was varied so that in the regions of greatest hardness changes the difference in diameter of the consecutive test pieces was least. The elongation values increased progressively as the center and softer portion of the rod was approached. The tensile strength showed a reverse relationship and indicated a fairly close parallel between the variations in hardness and the tensile strength. A study of the directional effect showed both the tensile strength and elongation values to be greatest in the longitudinal direction and least in the transverse, with intermediate values at 45°. The impact values showed a similar directional effect. The variation observed in hardness and tensile properties over the cross section of the rod does not show itself in any marked degree in the microstructure. X-ray examination showed much more evidence of structural changes. Irrespective of the condition of the rod, the hardness at the distance of 0.7 R from the center of the rod has been found to be practically the same as the mean hardness of the rod. On 1¼-in. rods, drawn with an 18.5% reduction, the greatest variation noted in tensile strength over the cross section was 6.2 tons/in.^{2} and on a 2½-in. rod, drawn with a 4.7% reduction, 3.65 ton/in.^{2} With regard to the bearing the results may have on normal testing procedure, hardness tests of material similar to those tested give informative results on other than soft rod only if the tests are carried out on at least 3 positions over the cross section. With rods too large in diameter to permit testing in full cross section, a close approximation to the average tensile strength would be obtained with test pieces cut eccentrically as near as possible to the outer surface of the rod. RWB (D-4b)

Determination of the Spreading of Magnesium and Aluminum Alloys and the Most Favorable Temperature and Speed for Rolling (Ermittlung der Breitung sowie der günstigsten Walztemperatur und -Geschwindigkeit beim Walzen von Magnesium-und Aluminiumlegierungen) H. SEDLACZEK, H. ZAPP & B. STOCKBAUER. *Z. Metallkunde,* Vol. 31, Mar. 1939, pp. 73-75. Experimental. The formula developed to calculate the spreading of Fe during rolling can also be applied to Al and Mg alloys. With Mg alloys, the least spreading occurs at 370° C., spreading increases with rolling speed, but, with the exception of alloys with Ag, speeds greater than 2 m./sec. with a reduction of 20% are feasible. The spreading is increased by additions of Al and Ag but not by Cd. The best rolling temperature for Al alloys is between 420° and 440° C., and reductions of 20% can be used if the rolls are well lubricated. Additions of Mg increase the spreading, but Cu, Si and Mn are not harmful. GD (E-4b)

a.c.f.

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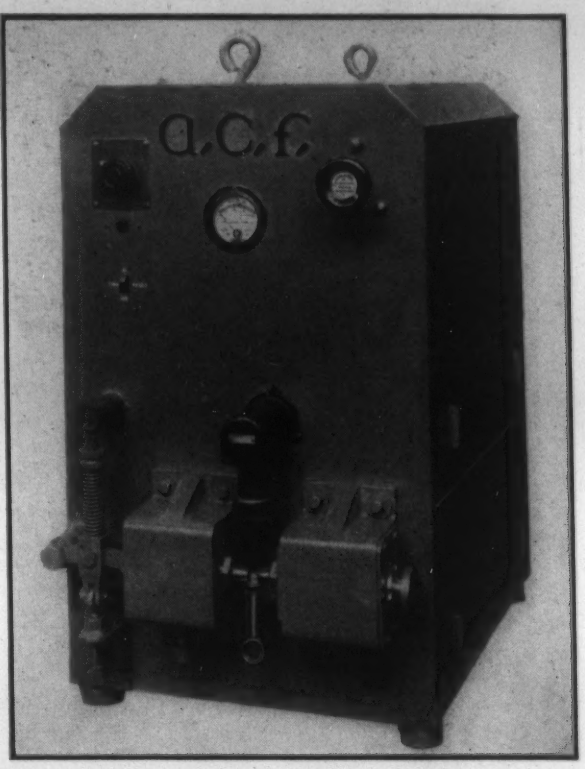

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O. E. HARDER, SECTION EDITOR

Service of Magnesite Powder in an Arc Furnace. V. M. ZAMORUEV. *Metallurg,* Vol. 14, Mar. 1939, pp. 46-55. In Russian. Practical. Frequent defects in the arc furnaces at the Kirov plant interfered with the smelting process and made it impossible to produce high quality steel. The defects were found to be due to the insufficient stability of the bottom and furnace magnesite slopes. This accounted for large amounts of magnesia found in the slags. The quality of various grades of magnesite used was tested. The quality of the magnesite was determined by its chemical composition, specific gravity, grain size and porosity. The results show that good magnesite powder should conform to the following specifications: Specific gravity not less than 3.5, porosity 35-40%, and the following grain size: (a) Less than 1% dust, (b) not over 30% of grains under 0.2 mm., (c) 20-30% of grains over 4.0 mm., (d) no residue on a 15 mm. sieve. The magnesite should contain 90-91% MgO, and not over 2.6% CaO, 3.8% SiO_2, 1.0% Al_2O_3 and 2.0-3.0% Fe_2O_3. Samples taken from the furnace bottom were also tested. The composition was found to vary with the stability of the material. The most stable one contained 60.28 MgO, 20.08 CaO, 15.58 SiO_2, 1.12 Al_2O_3, 2.60% FeO and traces of MnO, and consisted mainly of forsterite and small grains of periclase equally distributed among the relatively large forsterite grains. Small amounts of glass and mulilite were also present. BZK (5)

5a. Ferrous

O. E. HARDER, SECTION EDITOR

The Austenite Decomposition of a Vanadium Steel in the Undercooled State; the Dependence of the Decomposition Velocity and the Structure on Previous Treatment and Decomposition Temperature (Ueber den Austenitzerfall eines Vanadinstahles im unterkühlten Zustand; die Abhängigkeit der Zerfallsgeschwindigkeit und des Gefüges von der Vorbehandlung und der Zerfalltemperatur) F. WEVER & H. LANGE. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 21, No. 3, 1939, pp. 57-64. Original research. The causes and the mechanism of the decomposition of undercooled austenite are not yet completely understood; the effects of composition, previous treatment and temperature on the process were therefore studied, with a magnetic balance, on a V steel with 1.02% V and 0.78% C in the undercooled state. The transformation takes place in 3 stages: In the upper range from 700° to 540° C. pearlitic and troostitic structures are formed; in the intermediate range from 540° to 350° the structure consists of parallel bundles of needles, and the third range is that of martensite formation. The very characteristic formations of the intermediate range are very likely induced by a precipitation of V carbide. Undissolved V carbide particles act as nuclei in the 2 upper stages and reduce the time required for transformation; the structure becomes finer with decreasing starting temperatures (1180°-1075° C. in the tests). Magnetic examination of the phases formed in the decomposition showed that both in the upper and in the intermediate stage the same amounts of ferrite, V carbide and cementite are always formed, without appreciable mutual solubility; the transformations of the upper range are determined by a previous precipitation of ferrite, those of the intermediate stage by previous precipitation of cementite. 22 references. Ha (5a)

Aging of Supercooled Austenite of High Speed Tool Steel. I. I. BORNATSKII. *Metallurg,* Vol. 14, Mar. 1939, pp. 56-64. In Russian. Research. An investigation was made of the effect of aging of supercooled austenite on the microstructure and properties of high speed tool steel. Composition of the steel was 0.75 C, 0.30 Mn, 0.30 Si, 4.2 Cr, 17.4 W, 0.62 V, 0.016 S, 0.019 P, and 0.08% Ni. The points Ac_{1-3} = 820°-870° C. were determined with a Chevenard dilatometer. In all cases the temperature was measured with a Pt/Pt-Rh thermocouple. The temperature of the start of the martensite transformation was determined with the aid of a Rockwell indicator. Specimens of 15 x 15 x 7,5 mm. were heated to 1200°-1325° C., and after being held at those temperatures for 2 min., they were hardened in oil at 20° C. The results show that the upper temperature limit of hardening should be 20°-30° C. below the temperature of ledeburite formation. The transformation α Fe $\rightarrow$ γ Fe occurs in the interval 820°-870°. By increasing the temperature further and prolonging the time of heat treatment, the solubility of carbides in the austenite increases. It was impossible to dissolve all the carbides in the austenite because of the ledeburitic character of the steel. In cooling the steel there was observed a large hysteresis in the transformation α Fe $\rightarrow$ γ Fe. Short heat treatments for 2 min. at 1300°-1350° C. were found to reduce the temperature of the martensite transformation much lower than prolonged heat treatments at lower temperatures. The aging of the supercooled austenite is accompanied by the separation of carbides chiefly along the boundaries ot the austenite grains. The separation of the carbides is increased as the aging temperautre and time of the heat treatment are increased. Tests with high speed tools showed that the aging of supercooled austenite increases their stiffness. BZK (5a)

Full Annealing of Bar Steel (Mjukglödgning av stångstål) GUNNAR WALLQUIST & GUNNAR LARSSON. *Jernkontorets Ann.,* Vol. 122, No. 12, 1938, pp. 611-46. Descriptive. A continuous annealing process is described in which each bar is passed separately through an annealing furnace with the appropriate velocity. The temperature of each section of the chamber is kept constant, but the temperature of successive sections is maintained at a value to give the most suitable time-temperature curve. This was established by a series of full annealing tests on a hypereutectoid chromium steel (1% C, 1.5% Cr) in which hardness and structure were examined on test pieces 80 x 80 x 200 and 20 x 20 x 200 mm. under varying conditions of temperature, time and rate of cooling. By modifying these factors so as to obtain rapid heating, shortest possible times at annealing temperature, and cooling at various rates in different temperature intervals, the total annealing time was reduced to 9 hrs. as compared with the 20-60 hrs. now required. General principles of construction in annealing furnaces are discussed, and 80 microphotographs of the individual test pieces are given. HCD (5a)

Atomic Heat of Nitrogen in Various Nitrides-II. SHUN-ICHI SATOH. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 35, Mar. 1, 1939, pp. 385-398. In English. Original research. The present paper discusses the thermal data on nitrides of Mg, Ti, P, Be, Mn, Th, and Li. Applying Neumann-Kopp's law the atomic heat of N was deduced from the molecular heats of various nitrides which had not been considered in the previous paper. Abnormal decrease of the atomic heat of N appears to be a property common to all nitrides of the elements with small atomic numbers. The atomic heat of N may be provisionally estimated to have a value of about 3.5, which is considerably removed from the value 6.2 and to have the values of about 3.1, 3.7, 5.1 and 6.1 at 25°, 100°, 300° and 500° C. respectively. For earlier work, see also *Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 727 L/9. EF (5a)

Fireclay Bricks for Use in Iron and Steel Works. J. H. CHESTERS & T. W. HOWIE. *Trans. Ceram. Soc.,* Vol. 38, Feb. 1939, pp. 131-146. A survey of the properties of fireclay bricks for use in blast furnaces and steelmaking furnaces is presented, showing that the results of laboratory tests do not enable an accurate prediction of the behavior of the bricks in service to be made, but they do indicate whether it is safe to try the bricks in question. A 40%-alumina firebrick was found to be more resistant to certain slags than one containing 35%. The blast furnace stove dust attacks high-alumina bricks less than the medium-alumina variety. There is a tendency to use high-alumina refractories in runner bricks for casting high Mn steel. Thermal shock tests suggest the desired products can possess a high spalling resistance in spite of their dense texture. GTM (5a)

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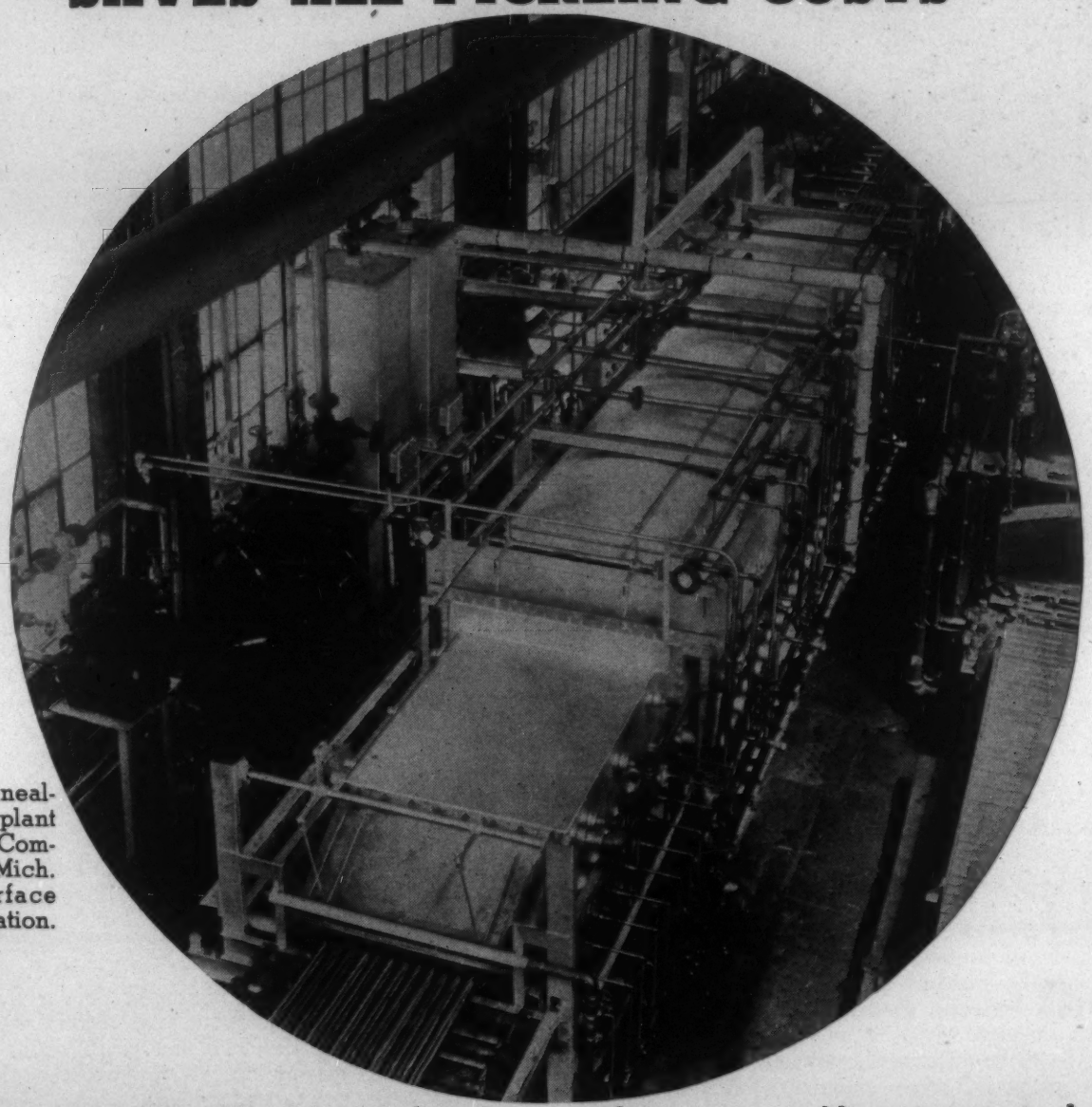

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O. E. HARDER, SECTION EDITOR

The Austenite Decomposition of a Vanadium Steel in the Undercooled State; the Dependence of the Decomposition Velocity and the Structure on Previous Treatment and Decomposition Temperature (Ueber den Austenitzerfall eines Vanadinstahles im unterkühlten Zustand; die Abhängigkeit der Zerfallsgeschwindigkeit und des Gefüges von der Vorbehandlung und der Zerfalltemperatur) F. WEVER & H. LANGE. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 21, No. 3, 1939, pp. 57-64. Original research. The causes and the mechanism of the decomposition of undercooled austenite are not yet completely understood; the effects of composition, previous treatment and temperature on the process were therefore studied, with a magnetic balance, on a V steel with 1.02% V and 0.78% C in the undercooled state. The transformation takes place in 3 stages: In the upper range from 700° to 540° C. pearlitic and troostitic structures are formed; in the intermediate range from 540° to 350° the structure consists of parallel bundles of needles, and the third range is that of martensite formation. The very characteristic formations of the intermediate range are very likely induced by a precipitation of V carbide. Undissolved V carbide particles act as nuclei in the 2 upper stages and reduce the time required for transformation; the structure becomes finer with decreasing starting temperatures (1180°-1075° C. in the tests). Magnetic examination of the phases formed in the decomposition showed that both in the upper and in the intermediate stage the same amounts of ferrite, V carbide and cementite are always formed, without appreciable mutual solubility; the transformations of the upper range are determined by a previous precipitation of ferrite, those of the intermediate stage by previous precipitation of cementite. 22 references. Ha (5a)

Aging of Supercooled Austenite of High Speed Tool Steel. I. I. BORNATSKII. *Metallurg,* Vol. 14, Mar. 1939, pp. 56-64. In Russian. Research. An investigation was made of the effect of aging of supercooled austenite on the microstructure and properties of high speed tool steel. Composition of the steel was 0.75 C, 0.30 Mn, 0.30 Si, 4.2 Cr, 17.4 W, 0.62 V, 0.016 S, 0.019 P, and 0.08% Ni. The points Ac_{1-3} = 820°-870° C. were determined with a Chevenard dilatometer. In all cases the temperature was measured with a Pt/Pt-Rh thermocouple. The temperature of the start of the martensite transformation was determined with the aid of a Rockwell indicator. Specimens of 15 x 15 x 7,5 mm. were heated to 1200°-1325° C., and after being held at those temperatures for 2 min., they were hardened in oil at 20° C. The results show that the upper temperature limit of hardening should be 20°-30° C. below the temperature of ledeburite formation. The transformation α Fe $\rightarrow$ γ Fe occurs in the interval 820°-870°. By increasing the temperature further and prolonging the time of heat treatment, the solubility of carbides in the austenite increases. It was impossible to dissolve all the carbides in the austenite because of the ledeburitic character of the steel. In cooling the steel there was observed a large hysteresis in the transformation α Fe $\rightarrow$ γ Fe. Short heat treatments for 2 min. at 1300°-1350° C. were found to reduce the temperature of the martensite transformation much lower than prolonged heat treatments at lower temperatures. The aging of the supercooled austenite is accompanied by the separation of carbides chiefly along the boundaries ot the austenite grains. The separation of the carbides is increased as the aging temperautre and time of the heat treatment are increased. Tests with high speed tools showed that the aging of supercooled austenite increases their stiffness. BZK (5a)

Full Annealing of Bar Steel (Mjukglödgning av stångstål) GUNNAR WALLQUIST & GUNNAR LARSSON. *Jernkontorets Ann.,* Vol. 122, No. 12, 1938, pp. 611-46. Descriptive. A continuous annealing process is described in which each bar is passed separately through an annealing furnace with the appropriate velocity. The temperature of each section of the chamber is kept constant, but the temperature of successive sections is maintained at a value to give the most suitable time-temperature curve. This was established by a series of full annealing tests on a hypereutectoid chromium steel (1% C, 1.5% Cr) in which hardness and structure were examined on test pieces 80 x 80 x 200 and 20 x 20 x 200 mm. under varying conditions of temperature, time and rate of cooling. By modifying these factors so as to obtain rapid heating, shortest possible times at annealing temperature, and cooling at various rates in different temperature intervals, the total annealing time was reduced to 9 hrs. as compared with the 20-60 hrs. now required. General principles of construction in annealing furnaces are discussed, and 80 microphotographs of the individual test pieces are given. HCD (5a)

Atomic Heat of Nitrogen in Various Nitrides-II. SHUN-ICHI SATOH. *Sci. Papers Inst. Phys. Chem. Research, Tokyo,* Vol. 35, Mar. 1, 1939, pp. 385-398. In English. Original research. The present paper discusses the thermal data on nitrides of Mg, Ti, P, Be, Mn, Th, and Li. Applying Neumann-Kopp's law the atomic heat of N was deduced from the molecular heats of various nitrides which had not been considered in the previous paper. Abnormal decrease of the atomic heat of N appears to be a property common to all nitrides of the elements with small atomic numbers. The atomic heat of N may be provisionally estimated to have a value of about 3.5, which is considerably removed from the value 6.2 and to have the values of about 3.1, 3.7, 5.1 and 6.1 at 25°, 100°, 300° and 500° C. respectively. For earlier work, see also *Metals and Alloys,* Vol. 9, Dec. 1938, p. MA 727 L/9. EF (5a)

Fireclay Bricks for Use in Iron and Steel Works. J. H. CHESTERS & T. W. HOWIE. *Trans. Ceram. Soc.,* Vol. 38, Feb. 1939, pp. 131-146. A survey of the properties of fireclay bricks for use in blast furnaces and steelmaking furnaces is presented, showing that the results of laboratory tests do not enable an accurate prediction of the behavior of the bricks in service to be made, but they do indicate whether it is safe to try the bricks in question. A 40%-alumina firebrick was found to be more resistant to certain slags than one containing 35%. The blast furnace stove dust attacks high-alumina bricks less than the medium-alumina variety. There is a tendency to use high-alumina refractories in runner bricks for casting high Mn steel. Thermal shock tests suggest the desired products can possess a high spalling resistance in spite of their dense texture. GTM (5a)

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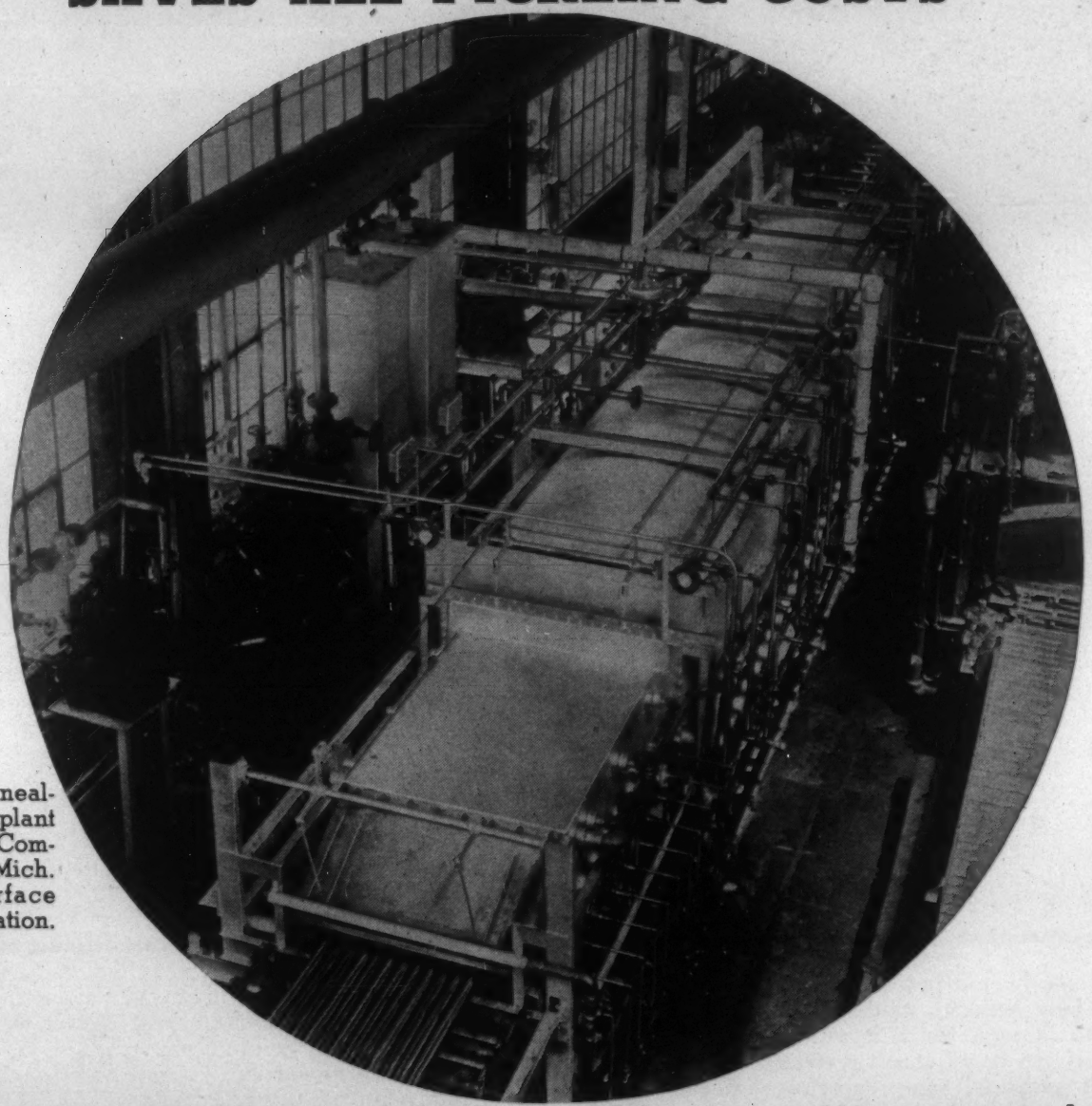

Open-fired, bright annealing GAS furnace in plant of the Mueller Brass Company, Port Huron, Mich. Photo courtesy Surface Combustion Corporation.

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6 Welding and Cutting

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E. V. DAVID, SECTION EDITOR

How to Apply Hard-facing Materials to Oil Well Drilling Bits and Other Cutting Tools. CHARLES H. SHAPIRO (Reed Roller Bit Co.) *Ind. & Welding,* Vol. 12, Apr. 1939, pp. 20-23, 48-50. Practical. Prior to 1923, drilling bits of the soft formation type were redressed by wasteful and inefficient forging methods. The earliest attempts at surfacing bits with an acetylene torch were made by applying cast iron, tool steel, etc. Later, such materials were replaced by an homogeneous Cr-W-Co alloy, cast in the form of a welding rod. The advantages resulting from a welded-on overlay as compared to the tempering method were greater dependability, longer life, and increased footage drilled. Following the homogeneous hard surfacing rods, came the introduction during 1927-28 of the tungsten carbides. Although this was at first expensive, increased production soon materially reduced the cost. The cast carbides, because they are manufactured by a fairly simple and not too expensive melting procedure, find widespread use and application on tools for abrasion resistance. Cast or fused tungsten carbide as used for hard-facing material, can be purchased in the form of pieces with special or standard shapes. This material is also available in broken, irregular pieces of medium size called peas. It may be purchased as composite metal, tube metal, or as crushed, bulk material, graded and numbered according to the mesh screen through which it will pass. Though one does not necessarily have to be an expert acetylene welder to hard surface a drilling bit properly, some experience in the correct method of setting inserts and in the handling of an acetylene torch is required. Good oxyacetylene equipment and accessories are also of prime importance. The size of insert and the size of tungsten carbide particles to use on bits are generally selected by the operator from experience gained with field requirements. Not much of the very coarse tube metal or composite rod is being applied; the tendency is toward the medium fine and finer grain types. Tube metal, like inserts, should be laid down by means of an excess acetylene gas proportion in the flame. The author strongly recommends that the welding operation be followed by a treating procedure of some kind, preferably by normalizing at 1550° F.
CEJ (6)

Welding in Car Construction. V. R. WILLOUGHBY (Am. Car & Foundry Co.) *Ind. & Welding,* Vol. 12, Apr. 1939, pp. 40-43. Practical. The use of welding in the construction of transportation vehicles has, in the last few years, become quite prevalent. In the car structure there is a wide variation in the thickness of the material used for the various members. Probably the most important factor in facilitating the fabrication of a structure like a railroad car is the proper design of jigs. An effective jig must firmly hold the various parts to be assembled in their proper places and also be capable of being tilted or rotated so that the welding may be done at the best angle. The work should be divided into sub-assemblies, as far as possible in order to enable the use of simpler jigs and provide work distribution. The sequence of welding needs careful study so that the distortion, if any, will be uniform. For the attachment of sheathing and roofing sheets spot welds are advantageous. The fusion welding equipment used in car construction need be no different from that used in other industries where the materials to be assembled and the joints are similar.
CEJ (6)

Locomotive Welding at New York Central Railroad Shops. WILSON B. FISKE, *Ind. & Welding,* Vol. 12, Apr. 1939, pp. 14-17, 51-54. Practical. The modern trend to steam-lined construction has forced locomotive manufacturers to turn to welding. In 1900 it took 50 days to put a locomotive through the shops for heavy repair; now, with the use of air tools, electric and gas welding and other improved methods in making repairs, the time that a locomotive is in the shop has been reduced to approximately 15 days. Practically all welding at the Cleveland shops of the New York Central is done by hand, both electric arc and oxy-acetylene processes being used. Often a cast steel part is cut by the oxy-acetylene torch and a new cast steel part joined to the reclaimed part by welding. The broad side rails, which are 6 in. x 7½ in. solid steel at the smallest closed portions, where they are to be welded, are beveled on all 4 sides clear to the center point so that the weld will be completely through. All frame members are welded by the electric arc. All joints are chipped and ground off flush with the rest of the framework. Locomotive boiler work involves welding to a considerable degree. Cylinder repair represents a favorable opportunity for welding. The trend is toward cast steel instead of cast iron cylinders. A great many parts are reclaimed by the building up of worn surfaces. Before the extensive use of welding, such parts were often scrapped.
CEJ (6)

Recent Developments in Resistance Welding. W. S. SIMMIE, *Welding Ind., London,* Vol. 7, Apr. 1939, pp. 119-123. General review. The capacity of a transformer can be increased by about 20% by introducing water cooling in the secondary windings. Practically all welding timers are devices that control the time of the flow of current in the welding contactor coil circuit, the contactor being used to make and break the welding transformer primary circuit. Spot welding machines can now be obtained with a variable pressure control system. A heavy pressure is used to bring the metal surfaces together; during the welding period the pressure is reduced, and finally, after the welding period, the pressure is again increased to its original value for a pre-selected time. This is referred to as the recompression system. Lower pressures during welding should permit the use of smaller capacity transformers. A pressure reduction of 50% gives satisfactory results. The introduction of timing equipment has resulted in the rapid development of portable gun welders. Improvements in the construction of seam welding machines include air operation of the moving head, different types of water cooling systems, and methods of obtaining the rotating contact between the roll and the electrode spindle. The most interesting of these is the use of mercury betwen the electrode arm and the rotating head.
CEJ (6)

The X-ray Inspection and the Examination of Welds (La Radiométallographie et le Contrôle des Soudures) *Métallurgie et Const. Méc.,* Vol. 71, Jan. 7, 1939, pp. 11-18. General review. Gives in detail the imperfections that may occur in welding: (1) Geometric defects; insufficient penetration; insufficient fusion; blisters, inclusions, slags; (2) defects from structural heterogeneity and chemical composition; (3) defects from local stresses. These may be caused by the use of metals with poor weldability, bad electrode quality, insufficient preparation, bad welding, inadequate design or construction. X-ray inspection helps to find these defects and to correct procedure accordingly. The ranges of accuracy for radioscopy and radiography are given. The former are briefly described. For the latter, the limits are given with and without magnifiers; diagrams show the voltage necessary and the minimum size of defects that can be detected for different thicknesses of iron or steel, for a 4-ma. tube with 40 cm. focal length, and for a higher-powered tube. Sketches show German standards for arrangements of X-ray photographs, some of them with the application of a Sn-wedge. The methods of evaluating the results are given. It is shown, graphically, how the exact location of a faulty spot can be found by double exposure. The apparatus used is described, and methods of precaution against damage from X-rays or high voltage equipment given.
JMN (6)

Unionmelt Welding. *Steel,* Vol. 104, Jan. 23, 1939, pp. 48-51. Practical description of an automatic electric welding process particularly adapted to joining heavy materials and making long welds, developed by Linde Air Products Co. It is used commercially in welding steel from 16-gage to 3 in. thick in single pass at speeds ranging from 3 to 80 in./min., and employs a special welding head to feed bare welding rod and a granulated material to the work. The process is applicable to low C, high strength, stainless and other steels, and is also suitable for various nonferrous metals and alloys. Special alloying elements may be added to Unionmelt to produce weld metal of special analysis. Butt, fillet and plug welds can be made with any desired penetration or contour. A.c. or d.c. current may be used, or d.c. current superimposed upon a.c. Maximum current that can be used is about 4000 amp. Tabulates data on approximate maximum current required for various thicknesses of one-pass butt and fillet welds, also conditions for one-pass butt welds in low-C steel. Lists the various commercial applications.
VSP (6)

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Hard-facing Prolongs Service Life of Steel Mill Equipment. *Welding Engr.*, Vol. 24, Mar. 1939, pp. 25-28. Practical. Excellent examples of parts economically protected by alloy surfacings are: Hot flying shear blades, hot-work dies, punches, rolling mill entry guides, gag press hammers, coke pusher shoes, mud gun screws, gas producer stirrer bars, and ingot crane tong points. An excellent die can be made by hard-facing a blank of 0.40-0.50% C steel, or a steel of about the same C content containing 1.00-1.50% Ni, such as S.A.E 3140. When the working edges are to be hard-faced, it is more economical to make a die of one of these steels than to use more expensive materials. All applications can be efficiently made by the use of the oxyacetylene process. A recess is machined along the working edge of the die to provide a place for the alloy to be deposited. In general, the depth of the recess should be greatest in the direction of greatest stress, the ratio being about 2½ to 1. On a die used for stamping material up to 1/16 in. in thickness, the groove is about 1/8 in. deep, measured from the side of the working edge, and about 5/16 in. deep, measured from the working edge. Preheating to about 850° F. is recommended. A hard-facing rod 3/16 or 1/4 in. in diameter and long enough to complete the operation without interruption is probably the best technique. After the deposit, the piece should be heated up to about 1400° or 1500° F. and cooled slowly in a furnace or buried in powdered lime or mica. After the die has cooled to room temperature it is ready for finishing by grinding or other suitable machining. CEJ (6)

Heavy Mechanical Equipment in the U. S. A. A. E. GIBSON (Wellman Engrg. Co.) *Welding Ind., London*, Vol. 7, Feb. 1939, pp 3-7. Descriptive. It is generally recognized that American engineering structures are heavy and rugged. Steel mills and others demand machines that will stand abuse and perform their functions continuously without excessive repairs or replacements. This has brought into general acceptance three fundamentals of design: The shaping of metal in plate bending brakes or presses, the use of rolled sections such as the cylinder, the channel and the beam, and the use of the newer low alloy high strength steels, which are available in a large variety of analyses. There are three objectives sought in bending steel rather than welding separate plates to form the desired shape. The first is to reduce the amount of welding and thus the cost, the second is to increase the rigidity, and the third is to improve appearance. 46% of the welding required with separate plates has been eliminated. Other effective welding auxiliaries are the mechanical positioning machine that most large and progressive fabricators build to suit their particular needs. Extensive use of welding fixtures is recognized as an essential to low cost and to interchangeability of parts. The qualification of welding operators receives serious consideration; also competent engineering companies recognize that design is a function of engineering departments and not of the shop. CEJ (6)

6a. Ferrous

A New Automatic Electric Welding Method (Ein neues selbsttätig-elektrisches Schweissverfahren) FR. EGGELSMANN. *Maschinenbau Betrieb*, Vol. 18, May 1939, pp. 233-235. Descriptive. The Ellira-process (Unionmelt welding) is automatic electric welding with additions of filler material and a weld-powder, the latter being similar to a blast furnace slag. The powder conducts electric current in the molten state, and the resistivity is such that the energy is transformed into the required heat. In addition, the powder acts as a deoxidizer, and when molten it covers the melt while the weld is formed and thus protects it from the atmosphere. Equipment and operation are described. Micrographs show welds in the untreated and in the normalized condition. Tensile strength of welded steel St 37.21 was approx. 70,000 lbs./in.^{2} in the untreated state and approx. 62,000 lbs./in.^{2} in the normalized condition. The specimens were grooved so that the fracture occurred in the center of the weld. Notch impact values were 6.5 kg.-m./cm.^{2} and 14-15 kg.-m./cm.^{2} in the untreated and normalized conditions resp. The uniformity of the measured values is emphasized. Higher-C steels show a wide fine-grained heat-affected zone between a very narrow over-heated zone and the matrix. This is due to the reduction in cooling velocity caused by the weld powder. No embrittlement resulted, however. RPS (6a)

Welded Steel Buildings. VAN RENSSELAR P. SAXE. *Welding Engr.*, Vol. 24, May 1939, pp. 24-27. General review. Despite engineering inertia the trend is toward welded steel buildings. Economic savings are possible when welded designs are employed. Further competition in structural welding is a possibility that the regular steel fabricator must face. One of the problems is to develop field connections for field bolting which will require shop punching of small parts only. These may be shop-welded to the beams and columns thus forming the basis for bolted field assembly necessary to erect the steel. Standard shop details for the engineer who wishes to design a welded job are badly needed. CEJ (6a)

The Effect of Phosphorus on the Welding of Steel. A Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN (American Welding Society, Welding Research Committee) *Welding J., N. Y.*, Vol. 18, Apr. 1939, Supplement pp. 123-130. Comprehensive review. The usual percentages of P in solid steel are in solid solution. P has a reputation for segregating, and above about 0.15% decreases the ductility and notch impact value. It exerts a useful effect in raising the strength of some low-alloy steels. A number of foreign investigators have studied the effect of P in the form of PH_3 (phosphine) as an impurity in the acetylene on oxyacetylene welding. The phosphine within usual limits had no effect on welding. The ductility steadily decreased and the hardness increased as the P content of the weld metal increased. With 1.0 and 2.0% phosphine the welds contained numerous blow-holes or slag inclusions. Apart from dilution by base metal, the P content of weld metal deposited by bare electrodes is practically the same as the P content of the electrodes themselves. In bend tests multi-layer welds in steel containing 0.08% C, 0.058% S, 0.10% P made with covered electrodes failed at the junction of the weld with base metal on account of P segregation, which embrittled the fusion zone. One author states that steel containing 0.09% C, 0.43% Mn, 0.050% S, was easier and safer to forge-weld with 0.103% P than with 0.013% P. It was his opinion that P up to 0.11% maximum was beneficial to forge-welding. With higher C contents, P is not desirable. A smooth oxyacetylene flame cut was made without difficulty in an iron containing 2% P. Arc welds in steel containing 0.15% C, 0.60% Mn, trace Si, 0.09% P, 0.42% Cu have excellent tensile strength and ductility. The addition of up to 0.15% P to Cr-Cu steels does not affect the welding properties appreciably in a steel containing 0.10% C max., 0.50-1.50% Cr, 0.30-0.50% Cu, 0.10-0.20% P, 0.10-0.30% Mn, 0.50-1.00% Si. Oxyacetylene welds in a steel containing 0.10% C, 0.61% Mn, 0.19% Si, 0.62% Ni, 1.15% Cu, 0.102% P had good tensile strength and ductility and offered no difficulties. Tests were made on butt welds in a commercial low-alloy sheet containing 0.08% C, 1.06% Cu, 0.50% Ni, 0.35% Cr and 0.118% P. There was no air hardening and the strength and notch impact value were good, but the ductility was a bit low. P created no welding difficulties whatever. 58 references. CEJ (6a)

Gas Welding of Oil Well Casing. G. R. MILTON (Sinclair Prairie Oil Co.) *Intern. Acetylene Assoc. Preprint*, Mar. 1939, 2 pp. Practical. The oxy-acetylene method of running casing was not adopted as general practice by this company until 3 or 4 yrs. ago, because of the slowness of the methods of oxy-acetylene welding known prior to that time. Rigid tests were established for all welders. A cooling time of 1 min. after completing the weld was allowed on the first third of the string; the next third was allowed to cool 2 min. and the remaining third cooled for 3 min. before being run into the hole. 40-ft. sections were used and very little instruction was necessary to enable the drilling crew to handle the welded casing as expeditiously as ordinary screw casing. After the pipe was set and cemented, and allowed to stand in accordance with Railroad Commission rules, a hydrostatic test of 600 lbs./in.^{2} was made, with the pipe subjected to this pressure for 12 hrs. CEJ (6a)

Welded High Pressure Piping. ARTHUR N. KUGLER (Air Reduction Sales Co.) *Intern. Acetylene Assoc., Preprint*, Mar. 1939, 5 pp. Practical. For the purpose of this discussion pipe ½ in. thick and greater is classed as high pressure piping. The backhand technique was developed about 10 yrs. ago. In this procedure torch and rod manipulation are greatly simplified and further the width of the vee is reduced to 70°-75°. Welds of this type readily develop 100% the strength of the pipe on reduced section tensile tests. In all tests except the tensile test forehand welds will show lower values. In general, one layer for each quarter in. should be deposited; thus, for 1-in. thick pipe four layers are used. C-Mo steel is probably the best known of the special alloy steels used for the higher pressures and temperatures. A C-Mo oxy-acetylene welding rod has proved suitable for use. Pre-heating followed by a stress relief anneal are common in best practice. CEJ (6a)

Review of Latest Practices in the Pipe Line Field. W. B. POOR (United Gas Pipe Line Co.) *Intern. Acetylene Assoc. Preprint*, Mar. 1939, 5 pp. Practical review. Three major phases of advancement are indicated in reviewing progress made in the pipe line field during the last 12 to 18 mos. They are: Improvements in welding facilities with particular respect to new and improved tips and rod; stress relieving of arc welds using oxy-acetylene blowpipes; and the development and widespread acceptance of wrinkle bending. Wrinkle bending is a modification of the creased bend. It consists in heating with a regular oxy-acetylene blow-pipe one or more narrow bends of metal at right angles to the longitudinal axis of the pipe. Good practice would seem to indicate that a 5° bend per wrinkle is a maximum and that a 2-3° bend per wrinkle is better, with a spacing if possible of one pipe diameter. CEJ (6a)

PAGE

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Flame Cutting with Small Machines. WALTER B. VAN WART (Wyatt Metal & Boiler Works) *Intern. Acetylene Assoc. Preprint,* Mar. 1939, 3 pp. Practical. A small gas cutting machine consists of either one or two blowpipes held by some sort of supporting frame on wheels driven by a variable speed motor through a gear reduction unit to a grooved or knurled drive wheel. They weigh 40-50 lbs. and have cutting speeds up to 60 in./min. A good machine in the hands of a trained operator will produce perfect cuts. The use of cutting machines not only saves time but aids in the preparation of the edges so as to secure a better job of welding. A plate planer has a tendency to cover up lamination defects, while a cutting machine will bring them out. A small shape-cutting machine is an indispensable piece of equipment to those engaged in any phase of the steel industry. CEJ (6a)

Welding of Stainless Alloy Sheet. C. H. S. TUPHOLME. *Sheet Metal Ind.,* Vol. 13, May 1939, pp. 674-676. Gas welding is used widely, especially for the lighter gages. It is slower than the electric arc method and more likely to produce buckling and warpage. Electric arc welding with reversed polarity gives very satisfactory results if coated electrodes are used. 18-8 has a high coefficient of expansion, and allowance must be made for this in setting up the job. The 18% Cr steel is welded similarly to the 18-8, but less warpage occurs, owing to its lower coefficient of expansion, and the welds will be relatively brittle. Welds of 12% Cr may be toughened by annealing, but the straight Cr steels with 18% or more Cr do not respond to heat treatment. Flash, seam, spot and projection welding are used less widely than gas and electric arc welding. JZB (6a)

Welding Broken Switch Tongues. W. H. HAYES (Georgia Power Co.) *Transit J.,* Vol. 83, Apr. 1939, pp. 129-130. Descriptive. If a weld is made between 2 pieces of a broken Mn steel switch tongue, so shaped that the welding surfaces are parallel and separated only enough to allow an electrode to be inserted between them, this weld is of minimum volume. The weld is started at the axis of the tongue and the bead continued, welding into both surfaces, in an outward spiral around this center until the surface is reached. The metal is thereby deposited at points equidistant from the center at nearly the same time. This weld contracts with greater uniformity than one built up from one side to the other, effecting savings in electrodes, electricity and welder's time. About 100 tongues have been repaired successfully. WHB (6a)

Electric Welding, Quantitative Considerations. J. TER BERG. *Welding Ind., London,* Vol. 7, Feb. 1939, pp. 8-10. Original research. The electrodes made for the experiments contained a soft mild steel core with a diameter of 5 mm. while the coating contained ferrous and ferric oxide, quartz and aluminum silicate with potassium silicate as a binder. It was shown that 82% of the fused metal core was used in the weld, 12.5% was lost by spattering and about 4.5% was lost through oxidation by the coating, while evaporation plays only a minor part. If, instead of ordinary atmosphere, N_2 or compressed air were used as a gas environment, little change was observed, except that some Fe was oxidized by the flux. When a mixture of H_2 and N_2 was used this oxidation did not take place. It was shown clearly by these experiments that in the attempt to increase efficiency care must be taken not only to have a low loss from spattering, but also that the coating of the rod should possess little or no oxidizing power, or that this coating should give off gases during welding that form a reducing atmosphere around the arc. In any case the idea that the slag protects the molten metal from the action of O_2 is in its general form incorrect. [No mention is made of the composition of the plate upon which weld tests were made or of the technique, current (a.c. or d.c.), polarity or speed of welding. These factors undoubtedly also have their effects.—C. E. J.] CEJ (6a)

Contractors Use Welding for a Quick Job. C. M. MCFADDEN. *Ind. & Welding,* Vol. 12, Apr. 1939, pp. 36-38. Practical. The Jahn & Bressi Construction Co., of Los Angeles, poured 561 linear feet of monolithic concrete siphon across Fortuna, Wash., on the Gila irrigation Project, in Arizona, in 20 days. The siphon barrel is horseshoe-shaped outside, re-inforced with steel, with a wall thickness of 20-28 in., and an inside diam. of 19.5 ft. Various construction equipment made partly by cutting and welding and maintained by the same method made this fast progress possible. One of the numerous uses of torch and electrode in maintenance of a shovel or dragline is the rebuilding of teeth for the bucket or dipper. They were rebuilt by welding vee-shaped tips of plow steel to the worn tooth. They are cut with a machine driven torch from a 3 in. x 4 in. bar of plow steel, and then driven on the worn tooth. Tooth and tip are then closed together under a trip hammer, after heating in a forge. A bead of mild steel is run around the joints. It is then reheated and the point drawn out to the desired shape under a trip hammer. Mn steel teeth are made workable by welding on one of these plow steel tips, using 3/16 in. Mn steel rod or stainless steel. Reinforcing steel for the construction is held in place by a welded template. CEJ (6a)

6b. Non-Ferrous

Welding Rod for Gas Welding of Copper (Schweissdraht für Gasschmelzschweissung von Kupfer) *Maschinenbau Betrieb,* Vol. 22, Mar. 1939, pp. 155-156. Preliminary German Standard Specification. The surface of the welding rod is to be clean; special coatings are allowed. The cross section is to be constant, varying ± 0.2 mm. up to 4 mm. diam. and ± 0.4 mm. above 4 mm. diam.; variation in length is ±5%. The rod is to flow evenly with only very slight spraying. Welding rods for overhead and vertical welding should not be too easily fusible and should have sufficient "climbing ability." Minimum Cu content is 98%. Maximum impurities: 0.24% As + Pb, 0.03% Pb, 0.03% Fe, 0.03% O_2. The tensile strength should be at least 25,000 lbs./in.^{2}; the bending angle for sheets of 5-10 mm. thickness 180°, 12-16 mm. thickness 120°. The method of sampling is specified. Welding tests concern flowing properties and loss by burning. A sheet 200 x 100 mm. is used, the thickness being selected according to wire diameter. The sheet has to be preheated to dark red heat before each test. A weld is submitted to tensile test and folding test. 2 sheets 300 x 125 mm. are welded together. The size of the welding tip is selected according to the sheet gage. For sheets up to 2 mm. the I-weld, from 2-8 mm. the V-weld, and above 8 mm. the X-weld is used. The specimens are machined from the center of the sheet. The welds are hammered at dark red heat; no cracks should occur. The weld is machined to sheet thickness before hammering. Tensile and folding tests are carried out according to the specifications for tests on welds. They may be carried out on unhammered specimens and the chemical analysis may be checked, if required. Regulations for sampling are given. RPS (6b)

The Welding of Magnesium Base Alloys (Das Schweissen von Elektronmetall) A. KOPPENHÖFER. *Metallwirtschaft,* Vol. 18, May 5, 1939, pp. 383-387. Practical. Mg-base alloys can be divided into 2 classes in regard to weldability: (1) The AM503 (Mg-Mn) type, which are very weldable, and (2) the AZM (Mg-Al-Zn) type, which are weldable to a limited extent in that the bead has to be short in length or provisions made for relieving stresses, which otherwise would cause cracking. Mg-base alloys

can be readily gas-welded. Normally, an oxyacetylene flame is used for welding, though an oxy-hydrogen flame can be used. The same type torches as are used on Al can be employed. Both right and left welding are used. The angle of the flame to the weld piece should be 45°. A special flux is required. The flux has the properties of dissolving the oxide skin, of allowing the molten metal to come in good contact with the edges to be welded, and of preventing the burning of the molten weld metal. Welds must be so designed as to prevent the entrapping of flux, which will accelerate corrosion. After welding, the seam should be wire brushed and immersed for several hours in a hot alkaline dichromate solution. The welding rod used should be of approximately the same composition as the piece to be welded. By hot hammering the welds at 280°-320° C., the strength of the weld can be increased to within 90-100% of that of the original sheet. For shop practice, welds should be tested and examined at frequent intervals in order to insure consistently good welding. Electrical resistance welding (specifically, spot welding) can be applied to Mg-base alloys without much difficulty. The piece to be welded and the electrodes should be kept clean. In contrast to gas welding, both the AM503 type and AZM type of alloys can be readily spot-welded. The atomic arc is used to some extent but ordinary arc welding is not used at all. GA (6b)

Long Carbon Arc Welding. W. C. Swift. *Metal Ind., London,* Vol. 54, Mar. 3, 1939, pp. 272-273. Descriptive. Until recently Cu has been found most difficult to weld. If ordinary Cu is held for a few seconds just under the melting point, the cuprous oxide present will segregate in the grain boundaries and the tensile strength will be cut 50%. The use of deoxidized Cu for welding will overcome this. Due to cost and limited size of sheets and plates in which deoxidized Cu can be supplied, its use has never been great. Trials with metallic arcs showed that even with very high current sufficient heat was not available to obtain good welds and no gas was produced to protect the hot Cu adjacent to the weld from the O_2 of the air. This proved that for welding Cu, higher voltages and carbon arc process would have to be used. It was possible with a long carbon arc to supply heat to the weld area faster than it was conducted away and to produce a carbon dioxide envelope that shielded the hot Cu adjacent to the weld from the O of the air. The short carbon arc contained considerable CO, which was absorbable in hot Cu. The weld rod composition is important. Rods melting slightly under the melting point of Cu are used. Other than cleaning and beveling plate edges, no preparation is necessary when using the "long carbon arc welding" method. Not only can Cu be welded to Cu and steel, but brass and bronze can be welded to each other, themselves and Cu and steel, obtaining joints that are both strong and ductile. In this process, 40 v. and 300 or 400 amp. equipment is required. RWB (6b)

Welding of Copper. C. H. S. Tupholme. *Sheet Metal Ind.,* Vol. 13, Apr. 1939, pp. 538-540. Practical. Cu has several properties that make it difficult to weld—high thermal conductivity, ready absorption of gas when molten, and rapid oxidation. Deoxidized Cu must be used, as any Cu_2O in Cu may be reduced, causing intergranular weakness. Also, any Cu_2O formed during welding will lead to structural weakness, Disadvantage of high thermal conductivity is usually overcome by covering surface of Cu with asbestos; a high rate of heat input is also necessary. The amount of deoxidizer that may be used is limited by its deleterious effect on electrical properties. Cu welding rods usually contain P or Si as deoxidizers. It is very important that neutral flame be used; O_2 excess will form oxide in weld metal, while Cu will absorb large quantities of CO, CO_2, H_2, etc. from reducing flame. Welding in vertical position is very difficult. Tacking is not possible, as red shortness of Cu will lead to cracks. It is desirable to peen weld while still hot, as this increases strength of weld to 75-90% of parent metal. JZB (6b)

Recent Lead Bronze Arc Welding Developments May Save Millions. W. C. Swift. *Ind. & Welding,* Vol. 12, May 1939, pp. 15-17, 40. Practical. If steel, under stress of at least 2,000 lbs./in.^{2} is heated to a red heat in the presence of molten brass, there is a rapid and deep intergranular penetration of the steel. In locomotives, with brass or bronze plates between the hubs and the boxes, frictional heat could not flow freely to the boxes or hubs to be dissipated but would be retained by the bronze or brass and build up to the melting point and then the steel would be seriously checked. Whereas Pb would be a desirable element in the brass or bronze surfacings on the outer ends of locomotive drive boxes, in oxyacetylene welding the presence of Pb in the weld metal slows up the work. Recently, it has been found that, while even a little Pb in a gas-welding rod is most detrimental, in an arc welding electrode it is not harmful and under the heat of the arc the Pb is refined and evenly dispersed throughout the bronze. This is believed to offer several interesting possibilities in the applications of bronze to surfaces subject to wear. CEJ (6b)

7 Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

7a. Electrolytic Methods

Effects of Carbonate and Sulfate upon Operating Characteristics of Cyanide Plating Solutions. R. O. Hull (E. I. du Pont de Nemours & Co.) *Proc. Am. Electroplaters Soc.,* 1938, pp. 190-206. Original research. Na_2CO_3 accumulates in cyanide baths as a result of the decomposition of cyanide. The addition of gypsum has been recommended as a means of removing CO_3 ion. This treatment leaves Na_2SO_4 in the bath, but its concentration can be reduced to 2-8 oz./gal., depending on the type of bath, by cooling to 40° F. The presence of SO_4 in the bath is less detrimental to the operation of the bath than CO_3. The "drag-out" of cyanide baths on removal of an article after plating amounted to about 8 fl. oz./100 ft.^{2} of plated surface. This was increased 28% by the presence of 15 oz./gal. of Na_2CO_3, but only 16% by 15 oz./gal. of Na_2SO_4. Curves are given for estimating the drag-out of a bath from a measurement of its viscosity. Na_2CO_3 and Na_2SO_4 affected the conductivity of plating baths about equally. In quantities up to 15 oz./gal. both salts increased the conductivity of Ag and Cu cyanide baths and decreased the conductivity of Zn and Cd cyanide baths. Na_2SO_4 in quantities up to 15 oz./gal. had practically no effect on the quality and appearance of deposits from cyanide baths. Na_2CO_3, in quantities above 10 oz./gal., decreased the bright plating range of Ag and Cd cyanide baths, but had no effect on the deposits from a Zn cyanide bath. Five oz./gal. of Na_2CO_3 improved the deposit from a CuCN bath. The cathode current efficiency of a Ag bath was decreased from 98% to 56% by 15 oz./gal. of Na_2CO_3, but was scarcely affected by 15 oz./gal. of Na_2SO_4. The anodic corrosion of iron tanks by cyanide baths containing Na_2SO_4 was slight, if the pH were sufficiently high. AB (7a)

Electrical Degreasing with Simultaneous Deposition of a Metallic Film (La elettrosgrassatura con contemporanea deposizione di un velo metallico) V. P. Sacchi. *Ind. Meccan.,* Vol. 21, Feb. 1939, pp. 117-123; Mar. 1939, pp. 215-219. Descriptive. The degreasing of a metal surface previous to electroplating in a bath that not only degreases but, at the same time, deposits a slight metallic film (preferably Cu but also Cd) is discussed, and methods and solutions for suitable baths described. The advantages of this method over simple degreasing are: (1) Cold baths that last for years if properly maintained can be used; in spite of their high original cost these baths are, therefore, very economical; (2) a better penetrating power, probably due to the deposition of Cu, which results in a greater H overvoltage than with Fe; (3) easier control of the degreasing process, as the Cu deposit is the most reliable indication of perfect degreasing since a firmly adhering Cu film can exist only on a perfectly degreased surface; (4) the phenomenon of passivation of the ferrous metal base during the transfer from the degreasing bath to the plating bath is greatly retarded by the Cu film, and an eventual passivity of Cu is much easier to eliminate than one of Fe. This degreasing Cu-plating method can, with advantage, be applied to Fe, steel, cast iron, Cu, all types of bronzes with Zn, Pb, Sn and white Zn-base alloys, but should not be used for parts that have to be plated

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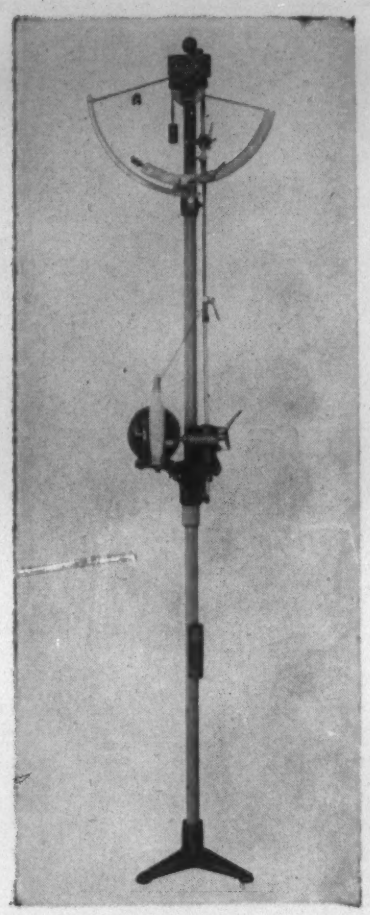

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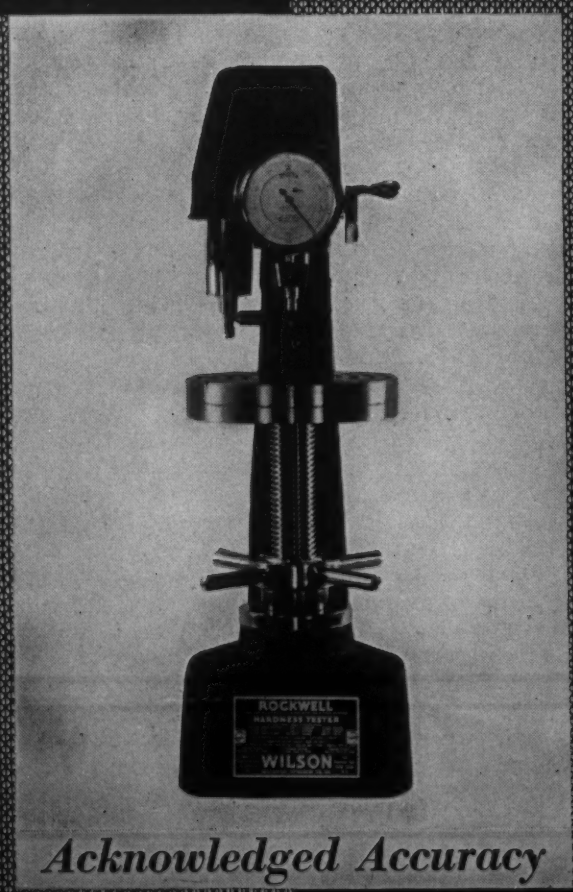

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with Cd or Zn as the direct contact, between the Fe and the Cd or Zn, is prevented by the Cu deposit; similarly, the method should not be applied to Ni-plated parts to be Cr-plated nor on Al and Al-rich alloys. The chemical reactions taking place in the bath, and solutions for the latter are given: NaOH, KOH, Na_2CO_3, K_2CO_3, NaCn, KCN, $Cu_2(CN)_2$, $K_6Cu_2(CN)_8$, NaCl, Na_2SO_4 and sodium metasilicate being mostly contained in them, in various proportions. The theory is explained at length. 22 references. Ha (7a)

7b. Non-Electrolytic Methods

Aluminum Coated Steel Wire. Details of a New Production Process. COLIN G. FINK. *Metal Ind., London,* Vol. 54, Jan. 27, 1939, pp. 135-136. Descriptive. Poor adhesion of Al to steel is largely due to the intervention of Al oxide or some other Al compound, and in order to obtain adherent Al coatings on steel wire, special treatment of the steel surface is required. The affinity of Al for oxygen at 25° C. is twice that for Fe, and in the molten state over 10 times. Carbon will not react with the oxygen but will with Al. From the practical standpoint atomic hydrogen is the only reagent available that possesses higher affinity for oxygen than Al at the molten bath temperature. Fe will absorb hydrogen and, as the temperature increases, its capacity likewise increases. The steel surface is prepared by treating with hydrogen at a higher temperature than that of the Al bath before passing the steel wire through the latter. Atomic hydrogen exudes from the surface of the steel at the moment of contact with the cooler bath and a perfect union of steel and Al is effected. The hydrogen not only prevents formation of Al oxide but reduces any Al compounds present. Tungsten carbide dies are very serviceable for drawing the wire to size after coating. A very intimate bond, of no definite composition, is obtained between the Al coat and the wire. The proportion of Al to Fe varies within wide limits. The brittle alloys of Al-Fe are at least ternary, containing C, O or other impurities; in the new Al-coating process, all contaminating elements are removed and the binary alloy produced is ductile. Properly-made Al-coated wire has a silvery white surface, is free from pinholes and other bare spots, is soft and ductile with high resistance to atmospheric corrosion. The wire, after anodizing is more resistant to abrasion than is galvanized wire. Such wire as Ni, Mo, stainless steel and nickel-chromium resistance alloy can be coated by this process. RWB (7b)

The Use of Ferric Sulfate for Pickling Copper Alloys. LOUIS F. LOUTREL, JR. (Monsanto Chemical Co.) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 26, Apr. 1939, pp. 263-270. Original research. The oxidizers now used in baths for pickling Cu alloys are HNO_3 and sodium dichromate. $Fe_2(SO_4)_3$ has a milder action and its use reduces the amount of pitting and etching. The annealing scale on common brasses (70% Cu, 30% Zn) consists of about 97% ZnO and is readily removed with H_2SO_4. The scale on brasses containing above 85% Cu has about the same Cu:Zn ratio as the alloy itself and is not readily removed by H_2SO_4 alone. A subsequent dip in a 25% $Fe_2(SO_4)_3$ solution will complete the removal of scale. The scale formed on Si bronzes (4.5% Si) contains SiO_2, which may be embedded in the pores of the metal. The pickling bath for these alloys is a solution containing 20% of $Fe_2(SO_4)_3$ and 2% of HF. The removal of scale from Cu-Be or Cu-Al alloys is difficult. The pickling bath used for these alloys is a 3-5% HF solution containing 30% of $Fe_2(SO_4)_3$. Ni brasses are pickled in H_2SO_4 and then in a 30% $Fe_2(SO_4)_3$ solution at 80-90° C. The $Fe_2(SO_4)_3$ solutions do not brighten brass as much as do the usual H_2SO_4-HNO_3 bright dips. AB (7b)

Metal Spraying. The Technique of Operation. J. G. MCGRATH. *Metallizer,* Vol. 7, Jan. 1939, pp. 2-4. Practical. Instructions are given on preparing the surface of material for metal spraying, methods of shielding and procedure in spraying. Outdoor metallizing should not be attempted in very damp or wet weather; indoor work should be metal-sprayed as soon after the surface has been cleaned and roughened as possible during damp weather. Small parts may be tumbled in a barrel while a metal spray is directed into the mass so that all parts are eventually coated thus obviating individual handling. In "alumetising" for heat resistance it is important to use Al of over 99% grade, brush or dip the sprayed material twice with sodium silicate, heat at 1850° F. for 10 minutes and air cool. BWG (7b)

Tinning Plant of Latest Design Installed at Ebbw Vale. *Tin & Its Uses,* No. 1, Apr. 1939, pp. 9-12. Concise, illustrated description of a new modern tin mill in Great Britain, covering the general features of construction and operation. Ten fully automatic tinning lines use Poole feeders, Davis feeders, welded steel tin pots with gas immersion heaters, caustic soda wet washer, bran dry cleaner, and automatic piler. Outstanding features are: Preparation of palm oil by centrifuging, automatic temperature control and recirculation of the oil, recovery of palm oil from wet wash solution and an elaborate fume removal system and a bran dust removal and recovery system. BWG (7b)

8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID

AND G. R. HARRISON,

SECTION EDITORS

The **Magnet Powder Process for Non-destructive Testing of Highly Stressed Machine Parts** (Das Magnetpulververfahren zur zerstörungsfreien Prüfung höchbeanspruchter Maschinenteile) E. A. W. MÜLLER. *Umschau,* Vol. 43, Mar. 12, 1939, pp. 255-257. Practical. Magnetic testing can be used in many cases where X-rays are either unpractical or uneconomical. Decreased permeability in defective zones forces the flux lines into a stray field which, in turn, exerts a magnetic force onto the Fe particles sprinkled on. Light knocking moves the particles toward the crack. The stray field extends over a larger zone than the flaw itself. Thus, capillary cracks become visible to the naked eye. Very fine Fe powder or iron oxide are most effective. The powder is mixed with a suitable type of oil and the mixture rinsed over the bar to be tested. Flaws below the surface also become visible. The ristinctness decreases rapidly with the depth. The power of the stray field is about the same on pores and inclusions as on cracks. The direction of the flux lines is to be selected in a right angle to the probable direction of the fissure. If this is unknown, it is recommended that the piece be magnetized in 2 directions at a right angle to each other. This can be achieved by clamping the test bar first in one and then in the other direction between the magnet poles. Another very convenient method works thus: The piece is held between the magnet poles and magnetized for testing on transverse cracks. Then, for detecting longitudinal cracks, the magnet is switched off and a current of high amperage (up to 2000 amp.) is sent through the bar in the direction of its axis; the specimen is not removed from its position. The a.c. produces a magnetic field rectangular to the axis and to any longitudinal crack. Both operations are conducted by turning a switch without moving the test bar. The method is applied not only for inspection during and after manufacture but also for the continuous supervision of vitally important machine parts. Not all the pieces showing flaws in this test have to be rejected. RPS (R-8)

Hardness of Thin Sheets or Foils. *Sheet Metal Ind.,* Vol. 13, May 1939, pp. 637-638. Descriptive. The Salford hardness tester makes an impression only 0.00008-0.00012 in. deep as compared with a Rockwell impression of about 0.00197 in. The impression is made by applying a load through a spindle to a 1/16 in. steel ball. The spindle movement causes an Fe core to move between 2 electromagnets in a Wheatstone bridge; this results in a change in the inductance of the magnets, which unbalances the bridge system and gives a reading on a galvanometer that is calibrated in mm. as well as in Rockwell units. Accuracy is about 2-5 Rockwell units and sheet and foil as thin as 0.0008 in. may be tested. JZB (T-8)

Some Applications of the Spectrograph to the Quantitative Analysis of Ferrous and Non-ferrous Metals. F. G. BARKER. (Naval Ordnance Inspection Lab.) *J. Iron Steel Inst.,* Advance Copy No. 1, May 1939, 35 pp. Practical. The fundamentals of spectroscopy and the applications of spectrographic methods to quantitative analysis of non-ferrous alloys are briefly reviewed. Experience with the quantitative spectrographic analysis of steel is then described in some detail. After variable results had been obtained with an arc source, a spark source was used successfully. The spark was formed by a 15,000 volt source between a pointed graphite rod and a flat surface of the steel being analyzed. An interrupter was not used. A condenser of about 0.005 microfarads was employed, but no intentionally added inductance was used. Density of the pertinent lines was determined with a microphotometer. Analysis is made by determining the ratio of density of a line of the element to be determined to that of a nearby Fe line. Curves for Cr, Ni, Mn, Si, V and Mo are shown. Repeat analyses by spectrographic determinations are given to prove that the method is accurate. It is much more rapid, and therefore cheaper, than wet methods of analyses. A study of the influence of variation in exposure, variation in time and temperature of development, preliminary sparking, and influence of shape and material of upper electrode is described. Changing the structure of a steel by heat treatment did not influence the results of spectrographic analysis. JLG (H-8)

Apparatus for Materials Testing by the Magnet-powder Method (Prüfeinrichtungen für die Werkstoffprüfung nach dem Magnetpulververfahren) *Simens-Z.,* Vol. 19, Mar. 1939, pp. 136-138. Description of commercial testing equipment. A crack-tester is available that allows determination of both transverse and longitudinal cracks. The first is achieved by lengthwise magnetization from a d.c. magnet, the second by transverse magnetization by a.c. excitation. The specimen is held in 2 rotatable chucks; thus it can be turned into the most favorable position for observation and rinsing. After testing, the specimens are demagnetized, likewise without being removed from the chucks. For the continuous inspection of hollow parts in large quantities, a machine working entirely on the a.c. separate excitation principle is used. A very handy portable crack tester consists of a high-current transformer and 2 electrodes with cooling ribs. The electrodes are brought in contact with the metal to be tested whereby the latter is magnetized. The iron in oil can be applied by means of an oil can. This tester is used for testing welds and sheet in excess of 5 mm. in thickness. The magnetic flux principle is applied in a hand tester using a permanent magnet. It is used for welds and sheets less than 5 mm. thick. RPS (R-8)

A New Bend Test (Ein neues Biegeprufverfahren) H. GUTH. *Metallwirtschaft,* Vol. 18, Mar. 3, 1939, pp. 188-190. Descriptive. A bend test machine suitable for some non-ferrous materials is described. In one operation the minimum bend radius that a sheet will stand without cracking can be determined. Essentially the apparatus consists of a long male die, machined so that one side is half a conical surface beginning at one end of the die. The male die fits into a female die. The sheet is then bent between 2 dies. In use, the dies are displaced an amount determined by the thickness of the sheet being tested. That is, they are displaced till the sheet fits in between the 2 dies. Knowing the slope of the conical surface, the dies can be calibrated so that the displacement of the dies can be readily determined. The dies are also calibrated so that simply by measuring the length of the crack that starts from the peak of the cone the minimum bend radius that the sheet will stand can be easily ascertained. GA (T-8)

Testing of Hardness of Knife Edges and Disks of Balances During Calibration. II. Investigation of the Accuracy of the Pre-load Hardness Test (Prüfung der Härte von Waagenschneiden und -pfannen bei der Eichung. II. Untersuchung über die Genauigkeit der Vorlasthärteprüfung) H. JOHANNSEN. *Physik. Z.,* Vol. 40, Mar. 15, 1939, pp. 115-201. Original research. An extensive critical study of the hardness testing method using pre-loads was made. The following sources of inaccuracies were particularly studied: Elastic deformations of the hardness tester, errors introduced by the dial gauge, shape of diamond penetrator, effect of idling, speed and time of loading, lubrication of surfaces, vibrations, deviation of hardness readings, comparative tests with other hardness testers, hardness variations in the testing material itself. The mean gages were found to be the greatest source of faulty readings. It is suggested that the range of tolerable hardness deviations be narrowed to one-half of the present tolerance limit. EF (T-8)

X-rays and their Application to Industrial Problems. F. W. SPIERS. *Machinery, London,* Vol. 53, Mar. 23, 1939, pp. 797-801. Practical. Equipment is described in detail. When the thickness of Fe to be examined is over 4 in., equipment with a capacity of over 300-400 kv. is required. 1-2% change in thickness as a result of internal faults may be detected. In order to locate exactly the defect, stereoscopic methods involving 2 exposures must be used. JZB (T-8)

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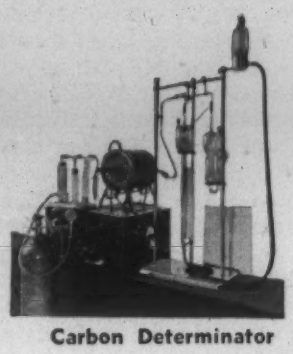

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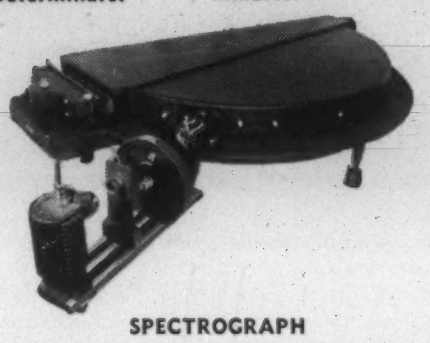

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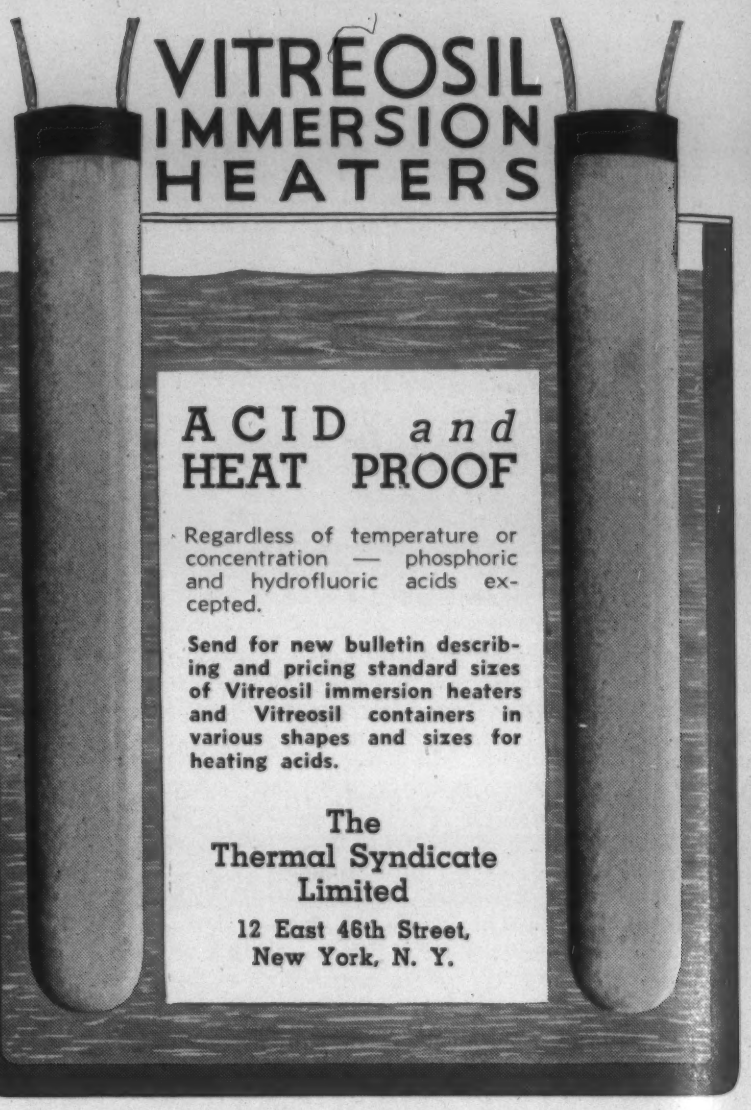

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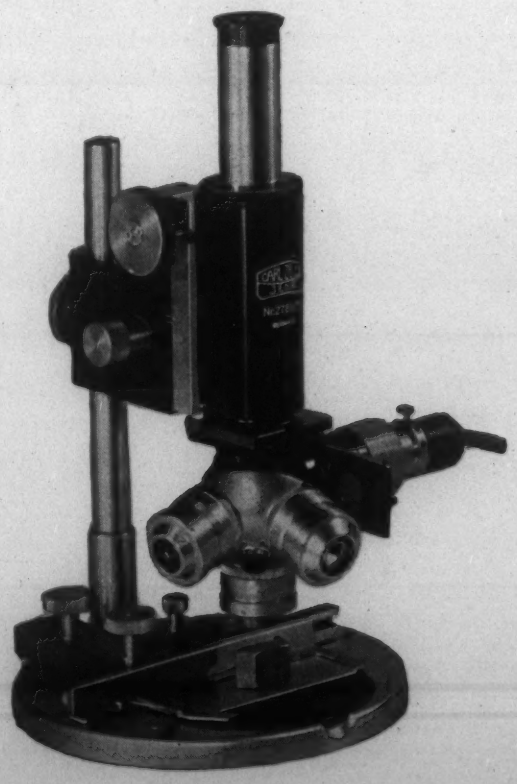

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8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Tensile-compression, Bending and Torsional Alternating Stresses in Steel Samples with Transverse Holes and Notches (Zugdruck-, Biege- und Verdrehwechselbeanspruchung an Stahlstäben mit Querbohrungen und Kerben) F. KÖRBER & M. HEMPEL. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch, Düsseldorf,* Vol. 21, No. 1, 1939, pp. 1-19. Research. The tendency to put modern methods of testing materials on a basis concordant with actual conditions is commented upon, and fatigue tests with 8 unalloyed and 6 alloy steels under tension-compression, bending and torsion are described in detail. When determining the effect of notches, the fatigue strength must be referred to the actual section, and "notch efficiency numbers" are developed to take the notch effect into account. Fatigue strength of solid rods and rods with changes in section depends principally on the tensile strength of the material. The harmful effect of holes and notches appears even with very small diameter of holes and notch depths. A great number of curves illustrate these conditions and give numerical values for the reducing effect. 31 references. Appendix: **Effect of Shape of Sample, Testing Machine and Manner of Procedure in the Test on Fatigue Strength** (Einfluss der Probenform, Prüfmaschine und Versuchsdurchführung auf die Wechselfestigkeit) M. HEMPEL. *Ibid.,* pp. 21-26. The author comments on the accuracy and reproducibility of test results, and shows by his own experiments and by survey of literature that the dispersion of test points in the curves is due to effects of differences in shape of the samples, however small, and of surface dissimilarities, to the testing machines themselves and to the manner of operating them. Special attention, for instance, should be paid to the presence or absence of roll skin or scale on the surface; also the samples should all be machined in the same manner; in torsional tests, frequency and angle of torsion must be exactly the same. A number of tables illustrate the effects of these different factors. 24 references. Ha (8a)

Effect of Manner of Loading on the Fatigue Strength of Steel Bars with Transverse Holes and Notches (Einfluss der Beanspruchungsart auf die Wechselfestigkeit von Stahlstäben mit Querbohrungen und Kerben) M. HEMPEL. *Arch. Eisenhüttenw.,* Vol. 12, Mar. 1939, pp. 433-444. Original research. The fatigue properties of several C and alloy steels were determined by means of tension-compression, repeated bending, and repeated torsion high tensile steels even shallow notches or small drilled holes tests, using ordinary and notched and drilled test pieces. The effect of notches increased markedly with the tensile strength; in produced undesired lowering of the fatigue properties. In the tension-compression and bending tests, the effects of notches and of drilled holes were similar. Sharp V-notches with angles between the sides of V of 30-120° had similar effects. The results obtained are correlated with published data in an extended review. 26 references. SE (8a)

Historical Development of Surface Hardening by Pressure for Improvement of Fatigue Resistance (Geschichtliche Entwicklung des Oberflächendrückens zum Zwecke der Steigerung der Dauerhaltbarkeit) O. FÖPPI. *Miss Wöhler-Inst.,* No. 36, 1939, pp. 49-59. Cold working the surface to improve endurance resistance is claimed as an accomplishment of the Wöhler Institut, or directly resulting therefrom. Citations from the literature are given to substantiate this view. Early hammering of piston rings and surface rolling of railway axles in Germany are stated to have been done originally for other purposes. Exception is taken to the statement by Sachs in *Metals and Alloys,* Vol. 10, Jan. 1939, p. 23, that surface rolling of propeller shafts introduced by him about 1933 was probably the first case of practical application. [The matter seems to hinge on what degree of use is appraised as practical application.—H. W. G.] HWG (8a)

Cloudburst Surface Hardening for Improvement of Endurance (Oberflächendrücken zum Zwecke der Steigerung der Dauerhaltbarkeit mit Hilfe des Stahlkugelgebläses) O. FÖPPL. *Mitt. Wöhler-Inst.,* No. 36, 1939, pp. 44-48. To produce the same degree of surface hardening in shot blasting, one may use 5 mm. balls at 4.2 m./sec. or 1 mm. balls at 9.5 m./sec. It is suggested that a pretreatment with 3 mm. balls to harden a depth of 0.5 to 1.5 mm., followed by treatment with 0.2 mm. shot at a higher velocity to super-harden the surface, should be advantageous in fatigue. Work is to be undertaken at the Wöhler Institut to demonstrate this. HWG (8a)

9 Metallography

Structure and Constitution. Metallographic Equipment.

9b. Non-Ferrous

C. S. BARRETT, SECTION EDITOR

The Ternary Silver-copper-palladium System in the Solid State (Der Aufbau des Dreistoffsystems Silber-Kupfer-Palladium in festem Zustand) F. GLANDER. *Metallwirtschaft,* Vol. 18, Apr. 21, 1939, pp. 337-341; Apr. 28, 1939, pp. 357-362. Original research. Investigation is made of the solubility gap in the Ag-Cu-Pd system, which is made of 2 binary systems showing complete intersolubility and a third that exhibits incomplete intersolubility. The binary Ag-Pd system has been represented as having complete intersolubility, though some data indicate that perhaps this is not true at low temperatures. The Cu-Pd system has complete intersolubility at high temperatures, but superlattices appear at 600° C. at compositions roughly corresponding to Cu-Pd and Cu_3Pd. The Ag-Cu system is of the eutectic type. The ternary Ag-Cu-Pd system has a solubility gap that extends into the ternary diagram from the Ag-Cu side. The extent of this solubility gap at the temperatures of highest solubility in the solid state (solidus temperature) was determined by microscopic examination of alloys quenched from high temperatures. Both microscopic examination and electrical resistance measurements were used to investigate the spread of the solubility gap at temperatures below the solidus surface. The solubility gap (2-phase region) is quite extensive at lower temperatures. At 400° C. it extends almost to the Cu-Pd binary system without being influenced by the transformations occurring in the binary system. The 2-phase region extends to the Ag-Pd system at 400° C. Though it was not possible to obtain microscopic evidence, the electrical measurements and general trend of the 2-phase region in the ternary system toward the Ag-Pd side of the ternary diagram appeared to indicate a 2-phase region occurring in the binary system at below 400° C. Isothermal sections depicting the spread of the 2-phase region at 800°, 700°, 600°, 500° and 400° C. are presented. Alloys containing 20-30% Pd and 60-70% Ag, as well as a few per cent Cu, are of interest as dental alloys and for fountain pen points. These alloys are heat-treatable. GA (9b)

The Osmium-phosphorus and Ruthenium-phosphorus System. Contributions to the Systematic Affinity Theory No. 85 (Ueber die Systeme Osmium/Phosphor und Ruthenium/Phosphor) W. BILTZ, H. EHRHORN & K. MEISEL. *Z. anorg. allgem, Chem.,* Vol. 240, Jan. 13, 1939, pp. 117-128. Experimental. X-ray and tensiometric analysis shows, in the Os-P system, one compound OsP_2 which, on dephosporization, goes directly over into metallic Os. In the Ru-P system 3 compounds were found: RuP_2, RuP, and a sub-phosphide of probable composition Ru_2P. HFK (9b)

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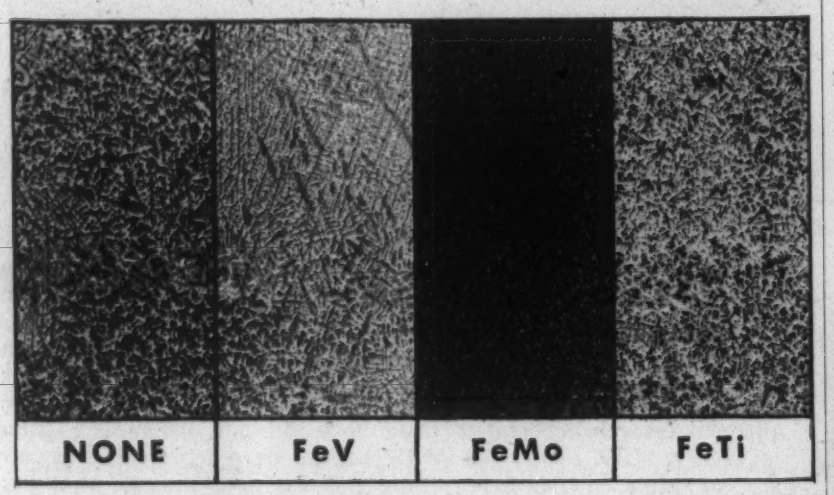

The macrographs above [from a report of the Research Inst. of the Skoda Works, Pilsen, presented as an exchange paper from the Czech. Tech. Foundry Ass'n, Sept. 1935] show the effects of different alloy additions on test ingots of .40 carbon steel made under identical conditions.

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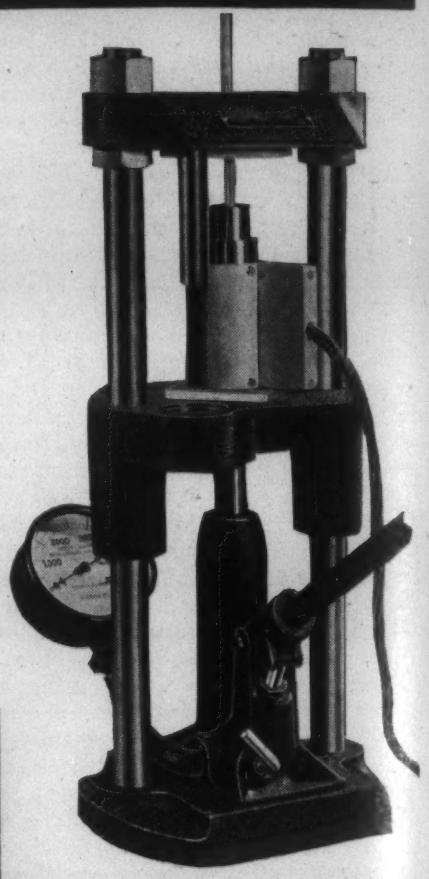

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10 Properties and Applications

Including Relation of Properties to Engineering or Product Design. See also Section 8a and 11.

M. GENSAMER, SECTION EDITOR

Metallic Materials for Thermocouples (Ueber metallische Werkstoffe fur Thermoelemente) A. SCHULZE. *Wärme,* Vol. 62, Feb. 25, 1939, pp. 127-130; *Metallwirtschaft,* Vol. 18, Mar. 24, 1939, pp. 249-254; Mar. 31, 1939, pp. 271-276; Apr. 14, 1939, pp. 315-320. Review. Of the thermocouples made from noble metals the Le Chatelier Pt/Pt-10% Rh couple used in a temperature range between 300° and 1600° C. is still the most important, it is possible to make up couples with a tolerance of ± 3° C. A noble metal couple comprising an alloy of Pd, Pt and Au (Pallaplat) as one leg and Pt-Rh as the other, which at 1000° C. will develop 49.55 millivolts in contrast to the 9.56 millivolts developed by the Le Chatelier couple at this temperature, has been used to a limited extent. The price of this couple is approximately half that of the Pt/Pt-Rh couple, but its life is considerably shorter and it is sensitive to furnace atmosphere. It also cannot be used at temperatures over 1000°-1200° C. Re, Os, W and Mo as well as other elements added to Pt in place of Rh develop a thermoelectric power against Pt, which is greater than that of Pt-Rh. The elements mentioned, especially Re, however, possess the advantage that their alloys with Pt up to 10% are workable. A Pt/Pt-8% Re couple will develop roughly a thermoelectric power 2.5 times that of the Le Chatelier couple. The life of this couple at high temperatures, however, is short, owing to excessive grain growth. The addition of Rh to produce a Pt/90.5% Pt-4.5% Re-5% Rh couple increases the life when used in gas tight protection tubes. A Rh/Rh-8% Re couple can be used up to 1800° C. For use up to 2000° C., an Ir/Ir-60% Rh couple has been developed. Tables of thermoelectric power and sensitivity are given for all the couples discussed over wide ranges of temperatures. Of the thermocouples composed of base metals, constantan/Cu, constantan/Ag and constantan/Fe couples are used in the low temperature ranges of from 0° to 600° C. For base metal couples that are required to stand up to 1200° C., Ni/Ni steel, Ni/C, Ni/Ni-Cr, constantan/Ni-Cr and Chromel-Alumel (Ni-Cr/Ni-Al) combinations can be used. Thermocouples of the constantan type can be made more heat-resisting by covering the positive base metal with Pt/Rh and the negative member of the couple with Pt. The coat will not alter the thermoelectric characteristics but will alter the terminal potential. Of the base metals, only W, Mo and Ta develop suitable thermoelectric properties for very high temperature measurements. A W/W-Mo couple can be used up to 3000° C. This couple and others of the same type have to be protected against oxidation at the high temperatures. Another important couple for high temperatures is the carbon/silicon carbide couple. The thermoelectric power developed by this couple is 30 times greater than that of the Le Chatelier couple. The couple is quite reproducible. For low temperature measurements where corrosion considerations are secondary, the important factor is sensitivity. The 2 couples, constantan/Cu and constantan/Fe, have high sensitivity at low temperatures with constantan/Cu capable of measuring liquid H temperatures. A method of making a very sensitive couple is to diffuse Cu into one part of a 0.0002 mm. Ni strip and Cr into another part, thus making a constantan/Ni-Cr couple. Te/Pt couples make satisfactory thermopiles in the temperature range —75°-90° C. GA + EF (10)

The Occurrence of Contact Arcs (Untersuchungen über die Entstehung von Kontaktbögen) H. PAUL FINK. *Wiss. Veröffent., Siemens-Werken,* Vol. 17, No. 3, 1938, pp. 45-69. Research. In a specially designed apparatus, minute contact arcs in air at atmospheric pressure are oscillographically recorded and interpreted. The following purified metals were used as electrodes: Cu (1 and 2 days old), Pb (5 days old), Ag (oxidized), Zn (2, 4, 8 hrs. old), Au, Ta, Pt, W (2, 5, 24 hrs. old), Ni, Ommet Fe (1 hr. old), and combinations of electrodes of Cu^+/Au^-, Au^+/Cu^-, Ag^+/Pb^-, Ni^+/Zn^-, Zn^+/Ni^-, and of 3 grades of Fe (carbonyl Fe with less than 0.04% C, Fe with 0.05% Ca and less than 0.04% C, and Fe with 0.2% C). The minimum arc voltage coincides, within 3.5%, with the ionization voltage of the metal under test. For this minimum arc voltage, only the anode metal is responsible under certain conditions. The mechanism of a short contact breaking arc is described qualitatively. The interpretation is based on a type of cathodic discharge that is identical with the kind of ordinary cathodic discharge in electric arcs. The testing results of the external e.m.f. in relation to the short-circuit current intensity, with reference to a constant minute arc length of about 0.3μ, yield curves for the various metals that are identical with known permanent arc characteristics. For these, the following equation holds: $(U - U_o)\ (I - I_m) = c$, wherein U is arc voltage, I is short-circuit current, U_o is minimum arc voltage, I_m is minimum current intensity of the arc and c is a constant, which is linearly related to the evaporation heat or to the boiling point of the electrode metals. The maximum dimensions of a capacity-free and induction-free circuit are evaluated for a case in which no discharges occur when breaking a metallic contact. EF (10)

Transition of Amorphous Metals into the Crystalline State (Der Übergang des amorphen Metalls in den Kristallinen Zustand) J. KRAMER. *Z. Physik,* Vol. 111, Dec. 8, 1938, pp. 409-422. Research. An amorphous metal modification is likened to a highly compressed gas where ionization of the metal atom at high temperature resembles the ionization of a gas. Amorphous layers have been produced by cathode disintegration in 9 hrs. with a current of 1 milliampere and 2,000-2,700 volts. The transformation temperature of amorphous metals can be displaced by both magnetic and electric fields which, according to the author, correspond to the Zeeman and Stark effects. For previous instalment, see also *Metals and Alloys,* Vol. 9, Apr. 1938, p. MA 246 L/1. **Supraconductivity and the Amorphous Metal Modification** (Die Supraleitfähigkeit und die Amorphe Metallmodifikation) *Ibid.,* Jan. 30, 1939, pp. 423-436. The amorphous metal modification is likened to supraconductivity in that both are influenced by temperature, external pressure and a magnetic field. Temperatures for supraconductivity and for transformation to the amorphous state lie close to each other for the following metals: Al, Zn, Mo, Cd, Sn, Hg and Pb. FHC (10)

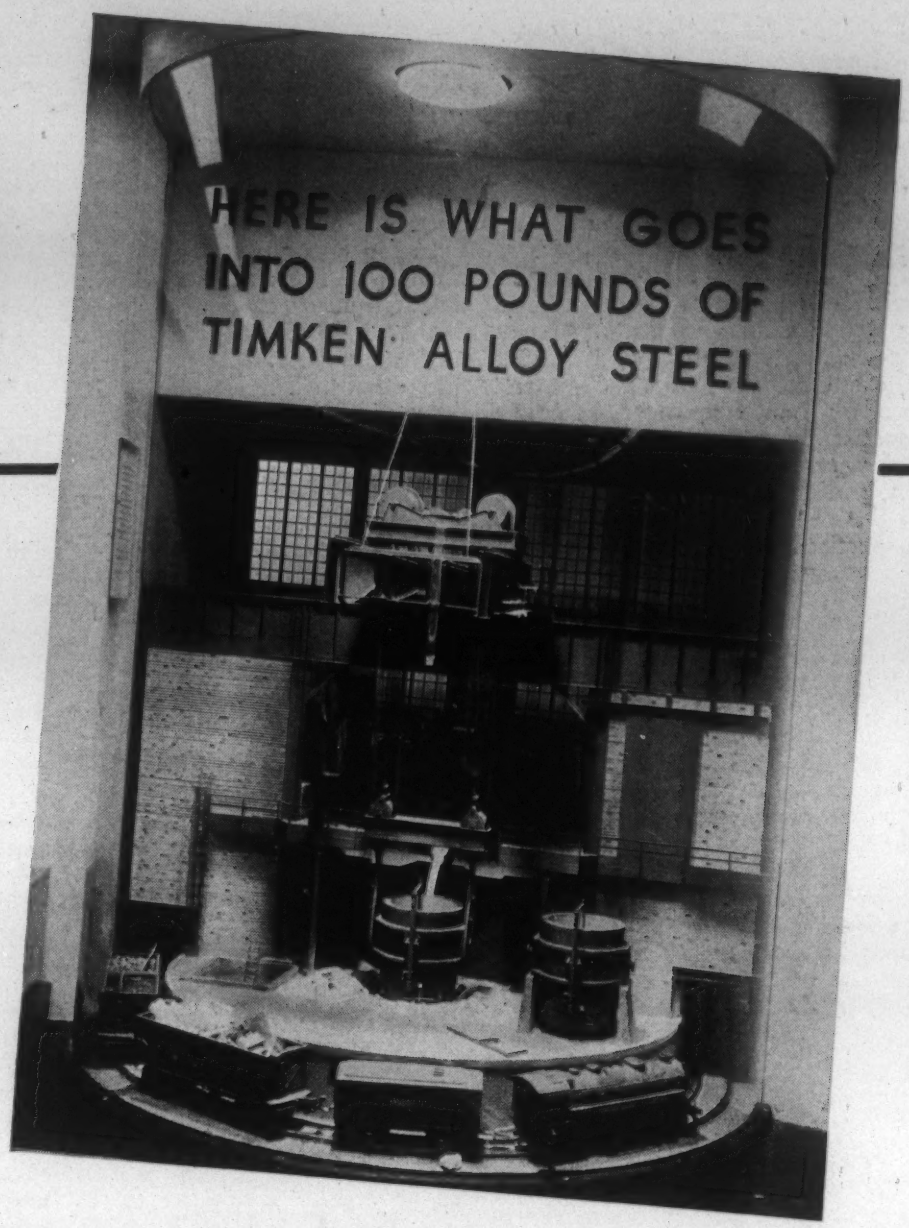
Recent Studies of Damping (Alcune recenti ricerche sopra lo smorzamento interno dei materiali) R. GIOVANNOZZI. *L'Aerotecnica,* Vol. 19, Mar. 1939, pp. 245-251. Brief note mentioning a few high spots in recent damping studies that were not covered in the previous account (see also *Metals and Alloys,* Vol. 10, Feb. 1939, p. MA 107 R/8). This serves as introduction to: **Bibliography on Internal Damping of Materials** (Bibliografia sullo smorzamento interno dei materiali) *Ibid.,* pp. 252-272. This carries 127 titles published between 1912-1938, most of which deal directly with damping of metals, though a few relate primarily to fatigue or notch-sensitivity and a few more to damping in nonmetallics. The titles are given in the language of the publication, so that the bibliography is useful whether the user can handle Italian or not. HWG (10)

10a. Ferrous

M. GENSAMER, SECTION EDITOR

Will American Molybdenum Replace Foreign Tungsten in New Tool Steels? *Steel Horizons,* Vol. 1, No. 2, 1939, pp. 7-8. The 0.80 C, 3.75 Cr, 8.75 Mo, 1.50 W, 1.00% V tool steel performs much like regular 18:4:1 high speed, but requires special precautions to avoid decarburization. Boron added to the Mo-W steel helped in avoiding decarburization but brought in forging difficulties. A steel of 0.80 C, 4.00 Cr, 6.00 Mo, 6.00 W, 1.50 V, 2.50% Cu has promise, however, from the point of view of reuse of scrap, the addition of another element adds to the complication. A steel called DBL, of 0.80 C, 4.00 Cr, 4.00 Mo, 5.25 W, 1.50% V, has been found to be a useful compromise as it hardens at a low temperature, 2200°-2250° F. (for all save lathe tools, where 2250°-2300° is used), without notable decarburization when heated as is good practice for 18:4:1. The hot-hardness is equivalent to 18:4:1, and its tool performance is also equivalent. This steel is close to one mentioned by Scherer (*Metals and Alloys,* Vol. 9, July 1938, p. MA 420 R/6), 0.80 C, 4.00 Cr, 4.00 Mo, 6.00 W, 1.00% V, which Scherer appraised as equivalent to 18:4:1. HWG (10a)

STEEL MAKING IN MINIATURE



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Magnetic After-effect in Weak Alternating Fields. I—Carbonyl Iron in the Recrystallized State (Ueber die magnetische Nachwirkung in schwachen Wechselfeldern. I—Karbonyleisen im rekristallisierten Zustand) HERBERT SCHULZE. *Wiss. Veröffent. Siemens-Werken,* Vol. 17, No. 2, 1938, pp. 37-57. Original research. Recrystallized carbonyl Fe shows 2 types of after-effects: (a) The known Jordan effect, which is superimposed on (b), an after-effect depending strongly on temperature and frequency. The latter was studied by a ballistic and magneto-metric method and found to indicate chemical activation energy. The frequency-depending after-effect (b) shows, for different frequency, a temperature course similar to that of resonance curves. While the ballistic method indicates no after-effect at low temperatures, the a.c. testing method shows the Jordan after-effect, which is entirely dependent upon frequency, but only slightly on temperature. By magnetization to the saturation point, both effects may be reduced. By demagnetization, (b) cannot be lowered to the initial value. Thus, a difference between the virgin and the demagnetized states was established. The Jordan loss assumes larger values in the demagnetized state below 20° C. than in the virgin state. An intimate relation between Jordan after-effect and hysteresis is apparent. This does not hold for (b). A drop of initial permeability with rising frequencies was observed, with losses up to 16% for differences between 60 and 5000 Hz. The frequency-depending permeability occurs in about the same temperature range as (b). By magnetization the frequency-depending portion of permeability, is also lowered, but to a more pronounced extent than (b). **II—Relation of After-effect of Carbonyl Iron to its Mechanical State** (II—Abhängigkeit der Nachwirkung von Karbonyleisen vom mechanischen Zustand) *Ibid.,* pp. 59-73. It was established that the strong temperature- and frequency-depending after-effect of carbonyl Fe occurs only in the recrystallized state, together with the always-present Jordan after-effect. The effect of residual magnetization, technical demagnetization and plastic deformation on both after-effects was studied. The experimental results are summarized in a very useful graphical presentation. **III—The Effect of Annealing on the Demagnetized State of Carbonyl Iron** (III—Der Einfluss von Anlassglühungen auf den entmagnetisierten Zustand von Karbonyleisen) *Ibid.,* pp. 68-73. The foregoing investigations demonstrated that the effect of residual magnetization on the frequency-depending after-effect of recrystallized carbonyl Fe cannot be abolished by technical demagnetization. In the present paper, it is shown that the initial state, with respect to the after-effect, can be restored by a 2-hr. anneal at 450° C. The new state, however, is not stable. If the testing temperature exceeds 160° C., the frequency-depending after-effect vanishes. This instability also shows up after a short annealing above the Curie temperature. The reaction initiated at about 160° C. also lowers the reversible permeability and hysteresis.
EF (10a)

The Effect of Nitrogen Additions and Heat Treatment on the Properties of High-chromium Steels. E. W. COLBECK & R. P. GARNER. *J. Iron Steel Inst.,* Advance Copy No. 4, May 1939, 37 pp. Original research. N was added to Fe-Cr by heating the crushed material to 1200°-1400° C. in a tube through which N was passed. After nitriding, the alloy was melted without loss of N. Small ingots containing from 21 to 28% Cr, some of which contained up to 2% Ni, and with different amounts of N were made and forged into bars. Samples were quenched from different temperatures and their impact resistance and tensile properties determined. Microstructures were also studied. Steels having a N content of the order of 1/100 of the Cr content had better mechanical properties, brought about by a finer grain size. The addition of 1% Ni resulted in additional improvement.
JLG (10a)

Nickel-iron-aluminum Permanent Magnet Alloys. WALTER BETTERIDGE. *J. Iron Steel Inst.,* Advance Copy No. 2, May 1939, 22 pp. Original research. The magnetic properties and the conditions for the heat treatment of Ni-Fe-Al magnet alloys were systematically investigated for the simple ternary alloys, for alloys with the addition of Cu, and for the Co-containing alloys of the "Alnico" type. The variations of the magnetic properties and the optimum heat treatment with the composition are given in a series of diagrams. C was found to be very deleterious. Reasons for the high coercive force of the alloys are discussed, but no very satisfactory explanation is available. JLG (10a)

Valve Spring Materials. H. E. BLANK, JR. *Automotive Ind.,* Vol. 80, Jan. 21, 1939, pp. 72-77. Review of changes made in valve spring materials, and their production since the introduction of high speed motors. Before the introduction of high speed motors, virtually any kind of wire was satisfactory for valve springs. Since this introduction, fatigue failures increased greatly on these wires. Many steels and heat treatments were tried but without success, owing to surface defects. Finally, the desired properties were found in a Swedish carbon steel wire. Better wires are now being produced by improved methods of manufacture, by increasing the corrosion resistance and by surface improvements with shot blasting. CMH (10a)

Development in Molybdenum High Speed Cutting Steels. WALTER R. BREELER (Allegheny Ludlum Steel Co.) *Trans. Am. Soc. Metals,* Vol. 27, June 1939, pp. 289-336; with discussion. Review plus research. The most popular analysis for Mo cutting steel at the present time is: C, 0.72 to 0.81%; Si, 0.20 to 0.45; Mn, 0.30 max.; Cr, 3.50 to 4.00; W, 1.30 to 1.80; V, 0.90 to 1.30; Mo, 8.00 to 9.50. These Mo steels have given difficulty with decarburization when heat-treated without special attention to atmosphere or protective coating on the work. Their advantages over the 18-4-1 W-Cr-V steel are lower cost and availability of Mo in this country. Five types of steel investigated in an effort to overcome the decarburization difficulty and improve the cutting properties are discussed. (1) Mo, 7-9.50%; V, 1.70-2.30; Cr, 3.50-4.50; Si, 0.20-0.40; Mn, 0.20-0.40; C, 0.75-0.90. Steels in this class are similar in physical properties to the Mo-W type but the tendency to decarburize is greater. (2) Mo-W and Mo-V steels with boron. Additions of 0.40-0.50% B give steels practically free from decarburization. There are certain disadvantages, however, such as poor forgeability, erratic recovery of B in melting, and narrow hardening range. (3) Mo-W and Mo-V steels with Cu and B. Typical analyses contain 2.60 to 3.00% Cu and 0.07 to 0.12 B. These steels are free from decarburization but show poor forgeability. (4) Steels containing Cu without B, of which a typical analysis is 6.00% W, 6.00 Mo, 1.50 V, 4.00 Cr, 2.50 Cu. This steel is in process of development and testing. Indications are that it is free from decarburization and that it shows good working properties at 2100° F. (5) Mo-W steel. Typical analysis: C, 0.75-0.85%; Mn, 0.20-0.40; Si, 0.30-0.80; Cr, 3.50-4.50; Mo, 3.50-6.00; W, 4.00-6.00; V, 1.00-1.60. This composition has exhibited good mill properties and does not seriously decarburize when hardened in a semi-muffle gas furnace. The best hardening temperature is 2275°-2325° F. Lathe and drill cutting tests indicate performance equal to 18-4-1 or better. One interesting observation regarding this analysis is that practically all carbides go into solution when the steel is heated for hardening, the matrix receiving the benefit of nearly all the W, Mo and V. A long and interesting discussion partly supports and partly attacks the author's conclusions. Gill mentions the results of 6,000 laboratory and field drill tests that show Mo-V steels to have a superiority of 36.1% in tool life over that of a similar number of Mo-W drills. Other discussions reflect the great interest in America in the Mo-W steels and growing satisfaction with them. Fetz reviews the considerable amount of German development and application of Mo steels. Bergen cites the need for early standardization among the high speed steels. HLW (10a)

Hoyer Steel-string Concrete (Stahlseitenbeton nach Hoyer) H. AMOS. *Z. Ver. deut. Ing.,* Vol. 83, Mar. 18, 1939, pp. 337-338. Descriptive. A new type of reinforced concrete is described in which the reinforcing material consists of steel wires (diam. up to 2 mm.) of a tensile strength of about 370,000 lbs./in.^{2} and an elastic limit of about 340,000 lbs./in.^{2} The wires are stretched before the concrete is poured to a stress of 170,000 lbs./in.^{2} To counteract the reduction of the prestressing by the shrinking of the concrete, the wires are stretched first to 200,000-210,000 lbs./in.^{2} The wires are placed longitudinally in the beam of concrete; lengths of 100 m. can be made and later subdivided without effect on the strength of the shorter pieces. A curve shows the total load supported by such beam and the sag as function of the prestressing in the wires, up to fracture. While a load of 10,000 lbs. with 25,000 lbs. prestress has a sag of 60 mm. and breaks at 90 mm. sag (10,500 lbs. load), the same sag with 8,800 lbs. prestressed wires occurs at 8,500 lbs. total load, and fracture at 11,000 lbs. and 105 mm. sag. The effect of wire diameter and quality of concrete is discussed briefly. The saving in steel as compared with a steel beam of equal load-bearing ability is about 97%, and as compared with the usual reinforced concrete, 90%. Ha (10a)

10b. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Copper and Health (Le Cuivre et la Santé) G. PY. *Cuivre et Laiton,* Vol. 12, Mar. 30, 1939, pp. 127-140. Comprehensive review of the health and clinical aspects of using Cu in cooking, preserving and plumbing. Normal drinking water contains up to 0.5 mg./l. Cu, while more corrosive waters have up to 5 mg. Cu that goes into foodstuffs can reach 1 mg. per day normally, which is far below the limit endangering health; the total Cu that can be absorbed by man is about 20 mg. per day. Cu acts variously, however, depending on whether it enters an empty or a full stomach; in the latter case, it is practically entirely absorbed by the vegetable pulp and eliminated. Clinical aspects of poisoning by copper salts, eventual sources of the poison from industrial applications and the therapeutic value of Cu are discussed at length. Ha (10b)

Technology of Alloyed Zinc Sheet (Technologie des legierten Zinkbleches) H. GRUBER. *Metallwirtschaft,* Vol. 18, Mar. 3, 1939, pp. 183-185. Discussion. Zinc sheet is divided into 3 classes: (1) Commercial Zn of a purity 98.5-99.0%; (2) fine Zn of a purity 99.5-99.99%; and (3) Zn-base alloy sheet containing small impurities such as Cu, Al, Mg, Sb, Cd and Mn, which act as alloying constituents. This article is concerned with the third group and with the possibilities of replacing other metals by Zn. The stress strain diagrams of Zn and Cu are compared, revealing that Cu has a much greater uniform elongation than Zn. This is ascribed to the different lattices of the 2 metals. Cu hardens during deformation while Zn stops hardening after very little deformation. In order to increase the deep drawability of Zn, the possibilities are: (a) To increase the amount of uniform elongation, or (b) to increase the amount of non-uniform flow, *e.g.* the necking of a tensile specimen. With regard to (a) this could only be accomplished by a change in lattice structure, which is not possible. However, the non-uniform deformation can be increased by suitable alloy additions resulting in an increased total deformation. Electrolytic Zn with 2% Cu has a total elongation of 35%, whereas commercial Zn will have an elongation of 18%. The alloyed Zn sheet has better forming characteristics than commercial Zn sheet. The latter, however, is superior as engraving plate. GA (10b)

Further Data on Gold-chromium Resistance Wire. THEODORE B. GODFREY. *J. Research, Natl. Bur. Standards,* Vol. 22, May 1939, pp. 565-571. Original research. Further investigation has confirmed previous work at the Bureau that Au-Cr alloys containing 2.1% Cr are well suited to the construction of the coils of precise electrical-measuring instruments. Although coils made of wire taken from different melts, and even coils made of wire from the same melt, have shown large differences in their response to heat treatment, it has been possible to make the temperature coefficient of resistance of any coil as low as desired in the range of temperature 18°-35° C. The resistance of such coils is extremely stable. A resistance bridge made with Au-Cr coils and without temperature control should be fully as good as the customary bridge with manganin coils and thermostatic control. Whereas heating a coil usually lowers the value of the coefficient, mechanical working raises it, and may be resorted to if a negative value of the coefficient has resulted from carrying the heat treatment too far. However, for highest stability of resistance, the results indicate that mechanical working as well as strain in mounting should be avoided. The pressure coefficient of resistance of a Au-Cr coil was measured and found to be equal to 1.1×10^{-6} per atmosphere. WAT (10b)

Recent Developments in Beryllium. PAUL M. TYLER. *Metal Ind., London,* Vol. 54, Apr. 7, 1939, pp. 400-401. Review. The world output still fails to exceed 500 tons a year. The major output is in the form of the Cu-Be master alloy. Price has always been a deterrent to more rapid expansion in the use of Be. Be in the master alloys runs $23/lb. [since this article was written, the price has been reduced to $15/lb.] but owing to the difficulty in fabrication, alloys of 2.25 Be run $1.12/lb. To meet the demand for an intermediate material between Be-Cu and P-bronze, a new group of alloys of 0.4-0.5% Be, 2-3 Co, remainder Cu (sometimes with Cr replacing the Co) are offered. Alloys of Be and Al or Mg have not been successful commercially. Almost the only use of the metal itself is for windows for X-ray tubes and electrodes for neon signs. Possibly the most significant development in Be in 1938 was the interest taken in the wider use of the element in munitions and more specifically in vital parts of airplane engines. Be is being used for cementation coatings on steel. There is a possibility of the oxide films being used to prevent tarnish on Cu and Ag. Ni with 2.5% Be hardens to 600 Brinell after quenching and drawing. Au with Be hardens to 300 Brinell. 36% Ni, 1% Be steel is rustless, and as machinable as regular Invar. The Be-Cu alloys are well known. RWB (10b)

Developments in High Tin Bronzes. *Tin & Its Uses,* No. 1, Apr. 1939, pp. 16-17. Practical. By improved degasification methods, high tin bronzes of up to 14% Sn have been made in which the Sn is entirely in solid solution and the alloy can be both hot and cold worked. Centrifugal casting helps, but, by melting under slightly reducing conditions and then treating with an oxidizing and then a reducing slag (British Pat. 436,204), excellent degasification is claimed. A 50% cold-worked, 10%-Sn bronze so prepared is said to give about 100,000 lbs./in.^{2} ultimate strength and 20% elongation, and to have improved corrosion resistance over ordinary α tin bronzes. BWG (10b)

Architecture Awakens to the Value of Light Metals. G. H. FRIESE-GREENE. *Light Metals,* Vol. 2, May 1939, pp. 158-168. Review. A discussion of the light metal materials available to the architect for both interior and exterior finishing. Methods of forming, finishing and application are discussed from the architectural viewpoint, in considerable detail. [This article touches upon an application of light metals not commonly discussed in the metallurgical journals. It might well be called to the attention of building engineers and architects.—A. U. S.] AUS (10b)

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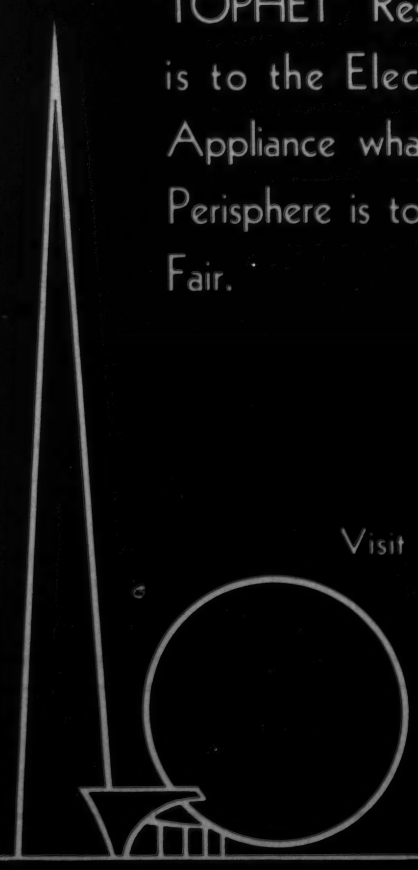

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Structural Principles for Replacing Heavy Metal Castings with Magnesium Castings (Konstruktions-Grundlagen für den Austausch von Schwermetallguss gegen Magnesiumguss) H. REININGER. *Metallwirtschaft,* Vol. 18, Mar. 17, 1939, pp. 235-240; Mar. 24, 1939, pp. 255-259; Mar. 31, 1939, pp. 277-282. An extensive correlated abstract of available data. Though the corrosion resistance of Mg in salt water, steam or some acids is poor, its resistance to atmospheric corrosion is as good if not better than cast iron. Mg castings in such places as airplane or automobile motors can be used without any surface protection because of the oil film that generally covers those parts. Mg castings are not subject to stress corrosion at stresses up to the yield strength. The tensile strength of Mg castings is equal to that of ordinary cast iron. However, the designer must consider that the light metal castings will undergo considerably more deformation because of their low yield strength before attaining the ultimate strength than will cast iron. With regard to temperature effects, the tensile strength of Mg castings is decreased but little by temperatures up to 100° C. but drops rapidly thereafter, and at 250° C. is approximately ½ of its original value. At low temperatures, the yield and tensile strength increase with only a very little drop in ductility. The designer must consider that so-called "data book" property values are usually obtained from coupons and that values obtained from bars cut from actual castings will vary widely. The author advises that, when necessary to use properties for calculating purposes, ½ the "data book" values will be absolutely "safe." Many factors, such as size of section and its influence upon microstructure, microporosity, flux and oxide inclusions, shrinkage cracks and internal stresses will effect the physical properties of Mg casting alloys. The compressive strength of Mg alloys is 1½ times the tensile strength, whereas for cast iron, the compressive strength is 4 times that of the tensile strength. The Brinell hardness of Mg castings varies from 32 to 60, depending upon the alloy. The modulus of elasticity of Mg varies from 5,700,000 to 6,300,000 lbs./in.^{2} and this is less than that of cast iron. This low modulus is of some advantage when a structure is subjected to a given deformation, in that the stresses will be smaller on a Mg casting. Examples are given of the design of ribbed sections so as to overcome the effect of a low modulus of elasticity. Tapped holes for bolts under stress should be bored with a drill that has a minus tolerance, while the bolts themselves should have a plus tolerance. The bolts should be at least 2½ times longer than the bolt diameter. The impact strength of Mg castings is greater than that of iron or steel castings. However, the Mg casting is more notch-sensitive and, accordingly, sharp edges, abrupt changes in cross section, etc., are to be avoided. The fatigue strengths of cast Mg alloys are equal to if not slightly better than the cast Al alloys. Fatigue values obtained from polished specimens cannot be applied directly to castings, which are strongly affected by shape, surface condition and heat treatment; finished sections or samples of the same shape should be tested to determine the endurance limit of a casting. Mg has a greater coefficient of expansion than Al and cast iron, and should not be tightly attached to either of the 2 metals if operating conditions are over 100° C. In the freezing and cooling of Mg, a large shrinkage in volume takes place. For the commercial Mg castings, this amounts to about 1-1.4%. The heat conductivity of Mg lies in between that of Al and cast iron. Taking the heat conductivity of air as 1, the heat conductivity of cast iron is 2400, that of Mg 6700 and that of Al 8700. The correct and incorrect design for Mg castings is liberally depicted by sketches and photographs. Illustrations are given of Mg castings, and corrosion protection of Mg castings is briefly discussed. GA (10b)

Trolley Wires from German Materials, Their Mechanical and Electrical Properties (Fahrleitungsanlagen aus Heimstoffen, ihre mechanischen und elektrischen Eigenschaften) W. LANG. *Metallwirtschaft,* Vol. 18, Jan. 6, 1939, pp. 16-21. Experimental. Tests were run on Al and its alloys, a bimetal steel-Al wire, Cu-clad steel wire, and a combination steel and Al trolly wire. The bimetal steel-Al wire is made by drawing a composite steel and Al wire. The Al portion serves as the current conductor while the steel has the necessary resistance to wear and tear. The combination wire of Al and steel is composed of an Al wire that carries the current and to which is clamped a steel wire. The conductivity of Aldrey (Al-Mg-Si) is about 55% that of Cu, of bimetal steel-aluminum wire (1 part steel to 2.65 parts Al) is 42% that of Cu, and of Cu-clad steel (1 part steel to 1 part Cu) is 41% that of Cu. Voltage drops are given for the various wires or combinations tested; of these, the voltage drop in the bimetal steel-Al wire is the same as that of Cu. The Cu-clad steel wire has a much greater voltage drop than a Cu wire of equal area. The physical properties of the various wires are given. For the bimetal steel-Al wire, greatest strength was obtained when the proportions of steel and Al were 1 to 2.65. Of the substitute wires, the Cu-clad steel has the greatest corrosion resistance. The atmospheric corrosion resistance of Al is satisfactory though not as good as Cu. Bimetal steel-Al wires also have proved satisfactory in normal atmospheres, no contact corrosion being noted. These substitute trolly wires will not contribute to interference with radio reception. The bimetal steel-Al wire, because of its greater cross-section, is somewhat stiff, making it very difficult to string; also, the necessity of stringing the wire so that the steel portion is underneath adds to the difficulty. The combination steel and Al wire requires more support than a Cu wire, and care must be used in mounting so as not to damage the Al wire. Taking all factors into account, the cost of Cu-clad steel wire is 20-25% more than a Cu trolly wire, of bimetal steel-Al wire 235-250% more, and for the combination steel and Al wire, 50% more. GA (10b)

Thermal Expansion of Nickel-copper Alloys at Low Temperatures. SIN'ICHI AOYAMA & TUNEZO ITO. *Sci. Rep'ts. Tohoku Imp. Univ.,* Vol. 27, Jan. 1939, pp. 348-364. In English. Original research. The thermal expansion of Ni-Cu alloys ranging from pure Cu to pure Ni was measured from 0 to —196° C. The results for all the alloys at various temperature intervals are given. A special dilatometer was constructed, the details of which are outlined. The expansion coefficients are smaller than calculated from the rule of mixtures. Each curve of α (coefficient of expansion) vs. composition is concave upward and shows a discontinuity since one side of the system is a paramagnetic solid solution, while the other side (Ni-rich) is ferro-magnetic. The tests were conducted particularly to test the theory of Gruneisen. This theory was found to hold for Cu, but not for Ni, as ferro-magnetic effects must be taken into consideration. See *Metals and Alloys,* Vol. 9, Sept. 1938, p. MA 569 R/9. AUS (10b)

Adhesion of Ceramic Masses on Metal (Zur Kenntnis der Haftfestigkeit keramischer Massen an Metall) GERLACH. *Alba, Beit. zur Kenntnis Edelmetal. als Werkstoffe in Zahnheilkunde,* 1938, pp. 92-104. Original research. Although porcelain seems to have certain advantages over dental alloys in many respects, all-porcelain bridge-work is not satisfactory. Research is concentrating on metal-porcelain combinations. The differences in thermal expansion and gas liberation in the metal during firing introduce difficulties. Pt-Ir alloys are most suitable. A static testing apparatus was developed by the author in which the adhesion of ceramic masses on dental alloys is tested under shearing stresses. The apparatus is hand-operated and the breaking load is indicated by a dial gage. Pt and Pt-Ir alloys (20% Ir) in polished and roughened condition were coated with various porcelain mixtures,

fired and tested. The Pt-Ir alloy, superior to Pt as to strength, yielded results. The tests with Pd-Ag alloys were not successful. In the majority of tests, the roughened metallic carriers gave the better adhesion values. EF (10b)

Small Piston Build-up at a Profit. ROBERT KIRKPATRICK. *Metallizer,* Vol. 7, Jan. 1939, p. 12. Practical. Hundreds of pistons of all types have been successfully coated with Zn for a bearing surface in Edmonton, Canada. It is believed to wear as efficiently as Al alloy pistons, and have non-scoring and oil holding properties. It is cheaply sprayed and adheres excellently to the parent metal if all oil has been completely removed from the piston. BWG (10b)

10c. Effect of Temperature

H. C. CROSS, SECTION EDITOR

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Testing of Tensile Strength at Elevated Temperatures in Long-time Tests Below and Above the Recrystallization Limit (Die Prüfung der Wärmefestigkeit im Dauerversuch unterhalb und oberhalb der Rekristallisationsgrenze) EBERHARD BOTH & WILHELM ROHN. *Vorträge Hauptversammlung deutschen Gesellschaft Metallkunde,* 1938, pp. 16-22. Research. Below the recrystallization temperature, alloys stretch under load and simultaneously strain-harden, which arrests further plastic deformation *(Dauerstandsfestigkeit).* Above the recrystallization temperature, creep is small at the start but accelerates with time ("Kriechfestigkeit"). Below the recrystallization temperature, the grain boundary substance is usually stronger than the grain so that fracture usually occurs through the crystals. At higher temperatures, this condition is reversed. At the "equi-cohesive temperature," which need not be the recrystallization temperature, the strength of grain boundary substance and grains are equal. Highly pure alloys are desirable where the grain is stronger than its boundary. Fine grain size is aimed at if the opposite is the case. Creep strength can be modified by thermal treatment and chemical analysis. Relaxation test results obtained with a variously treated alloy of 63 Ni, 15 Cr, 15 Fe, 7 Mo are graphically shown. Annealing at 1250° C. *(i.e.* above recrystallization temperature) doubled the life in comparison with annealing at 1050° C. The yield point at 20° C. of the material annealed at 1050° C. is twice that of the samples annealed at 1250° C.; apparently no correlation between room and elevated temperature behavior exists. Large grain developed during the 1250° C. anneal is believed responsible for the superior creep strength. Relaxation tests from 500 to 1000° C. yielded the following order of merit: (1) Fe (worst); (2) 70/30 FeCr; (3) Ni; (4) 65 Fe, 30 Cr, 5 Al; (5) 18/8; (6) 61 Ni, 19 Cr, 20 Fe; (7) 80/20 Ni-Cr; (8) 50 Fe, 30 Ni, 20 Cr; (9) 61 Ni, 15 Cr, 17 Fe, 7 Mo; (10) 40 Ni, 16 Cr, 21 Co, 6 Mo (best). Despite its higher melting point, Fe is less creep resistant than Ni. Ni-base alloys are better than Fe-base alloys. Co alloys appear to be highly creep resistant. Alloys to resist temperatures above 600° C. contain 15-20% Cr to insure oxidation resistance. 15-20% W increases creep resistance, and the same amount of Mo is even more effective. C and Ti block the slip planes and enhance creep strength. Allotropic transformations are harmful. The following alloy has the highest creep strength so far obtained: 35 Ni, 25 Co, 15 Cr, 10 Fe, 5 Mo, 5 W, 5 Ta. GN + EF (10c)

Influence of Varying Chromium and Silicon Content on High-temperature Characteristics of Steels. H. E. WHITE, C. L. CLARK (Univ. Mich.) & W. G. HILDORF (Timken Roller Bearing Co.) *Refiner Natural Gasoline Mfr.,* Vol. 18, Feb. 1939, pp. 58-72, 86. Original research. A series of 11 steels in the following groups were investigated: 1.0-1.5% Si, 0.5% Mo with Cr ranging up to 5%; 0.5-1.0% Si, 0.5% Mo with Cr from 1.23 to 2.5%; and 0.5% Si, 0.5% Mo with Cr up to 5%. Data are presented in the form of curves and tables. Photomicrographs of structures are also given. Conclusions are as follows: (1) Increased Si content over the range considered and especially in the presence of Cr increases (a) the room-temperature strength and hardness, (b) the short-time strength at 750° and 900° F., (c) the hot impact resistance, (d) the oxidation and corrosion resistance, (e) the rupture strength at the more elevated temperatures, and (f) the life of the steel in service, especially because of increased surface and structural stability. (2) On the other hand, increased Si content lowers (a) the room-temperature ductility and impact resistance slightly, and (b) the creep strength at the intermediate temperatures, especially under the more rapid creep rates. (3) Increased Cr content over the range considered increases (a) the room-temperature ductility and impact resistance, (b) the corrosion resistance, (c) the oxidation resistance at the intermediate temperatures, and (d) the short-time high-temperature strength and creep resistance in amounts up to 1.0-1.5% Cr. Insofar as the rupture strength and hot impact resistance are concerned, the effect of Cr varies, depending on the temperature and the Si content. (4) The results presented are believed to show definitely that very satisfactory steels for high-temperature service can be obtained through a proper combination of Cr and Si in the presence of 0.5% Mo. (5) While some may feel the number of steels considered to be excessive, it is believed that each is capable of rendering satisfactory service under certain conditions and that a wide choice must be available if the most economical steel is to be chosen for each application. VVK (10c)

The Permanency of Light Metals at Different Temperatures (Ueber die Dauerbewährung der Leichtmetalle Bei verschiedenen Temperaturen) G. GÜRTLER, W. JUNG-KÖNIG & E. SCHMID. *Aluminium,* Vol. 21, Mar. 1939, pp. 202-208. Useful data compilation. The design of load-bearing structures should be based not on short-time static characteristics but on dynamically determined values of fatigue strength and creep strength, and with due consideration of the effect of temperature on both. A "damage curve" is developed, giving the number of load oscillations that the material will stand until a definite injury occurs. The various methods used to establish fatigue and creep strength are discussed, and damage curves, creep strength and fatigue curves at different temperatures, from —50° (airplanes) to +400° C. (engines) given for a number of Al alloys. 26 references. Ha (10c)

The Effect of Deoxidation on the Tensile Properties of Steel Particularly at Elevated Temperatures (Der Einfluss der Desoxydation auf die Festigkeitseigenschaften von Stahl, vor allem in der Wärme) H. BUCHHOLTZ. *Stahl u. Eisen,* Vol. 59, Mar. 16, 1939, pp. 331-338. The effect of strong deoxidation, as with Al, in producing fine-grained steel is brought out very decidedly in the creep properties. Coarse-grained steels have a considerably higher creep resistance than fine-grained steels. The lower creep resistance of the fine-grained steels is attributed in part to the more rapid spheroidization of the carbides in such steels. SE (10c)

11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

The Anodic Solution of Alloys. F. R. MORRAL & J. L. BRAY (Purdue Univ.) *Trans. Electrochem. Soc.*, Vol. 75, 1939, Preprint No. 6, 14 pp. Original research. The authors measured the rate of anodic solution of 12 metals and 56 alloys in 20% H_2SO_4 by weight. This study was undertaken because of the corrosion of metals used near an acid electrocleaning bath. The rates of solution of the metals and alloys were reported as grams/amp. hr. Pb was the least corroded of the metals, losing 0.01 g./amp. hr. The introduction of 0.05% of Te into the lead decreased the attack to 1/10 that of pure Pb. The different kinds of Cr steels and stainless steels all had about the same rate of corrosion, namely 0.5-0.6 g./amp. hr. Various kinds of Ni alloys and Ni steels corroded at about the same rate as the stainless steels. Fe-Si alloys (containing about 14% Si) were resistant to anodic corrosion (loss = 0.03-0.1 g./amp. hr.) because a conducting film formed on the surface. However, these alloys are brittle and the surface film is also brittle and easily dislodged by vibration. Fe, Ni or Cu containing 27% Ti were about as resistant to anodic corrosion as Fe-Si and no visible film could be seen. The rates of solution of tungsten and molybdenum carbides mixed with other metals were also determined. AB (11)

Destruction of Cast Iron at Elevated Temperatures by Gases Containing Carbon Monoxide (Zerstörung von Gusseisen durch kohlenoxydhaltige Gase bei höheren Temperaturen) W. BAUKLOH. *Metallwirtschaft*, Vol. 18, Jan. 20, 1939, pp. 57-59. Research. Examination of cast iron that failed after subjection to a carbon monoxide containing gas for 1½ years at 500°-600° C. revealed that portions of the cast iron consisted of a fine powder with a high C content (30%), and the remaining cast iron was badly fissured. Steel parts located in the same critical reaction zone showed no signs of failure. Though the equilibrium curve for the reaction $2\ CO \leftrightarrows C + CO_2$ indicates that CO decomposes less as the temperature rises, the author has shown in a previous publication that the decomposition is catalyzed by finely divided Fe or Fe oxide and that the reaction has a maximum at 550° C. The mechanism of destruction of the cast iron proposed is that the CO penetrating along the pores in the cast iron decomposes therein to form CO_2 and C. Presumably the interior surfaces of the pores act as catalyzers. The C resulting from the decomposition of the CO widens the pores gradually, causing fissuring or splitting of the cast iron. GA (11)

Wear in Gliding, Dry Friction (Die Vorgänge beim Verschleiss bei rein gleitender trockener Reibung) K. DIES. *Z. Ver. deut. Ing.*, Vol. 83, Mar. 11, 1939, pp. 307-314. The process of wear (or abrasion) between 2 metals was studied more thoroughly on a sample of soft Fe on hardened Cr steel. Under no circumstances does wear increase proportionately to the pressure between the 2 samples, but under these conditions (dry gliding friction) wear as friction of load shows a maximum and a minimum. A discussion of this phenomenon indicates that chemico-physical processes play such a part that the chemical effects predominate over the mechanical. Unalloyed and alloyed steels and cast Fe showed similar behavior. 19 references. Ha (11)

Factors Influencing the Failure of Naval Boiler Tubes. A. P. CALVERT. *J. Am. Soc. Naval Engrs.*, Vol. 51, Feb. 1939, pp. 1-34. Original research. Tube failure is usually due to local overheating, ascribable to a variety of causes among which are design inadequacies that permit momentary dearth of water, steam binding, faulty material or construction, such as die marks or other imperfections and improper tube hardness, which may cause scored tube ends in rolling into tube sheet. Causes of failure chargeable to operation are considered as: Fouling of tubes owing to deposition of scale, oil or grease that retard heat transfer, obstruction of tubes by collection of foreign matter, pitting of tubes owing to Cu, improper water conditioning and O in feed water, and other causes. A survey was made of the microstructure of numerous failed tubes at the point of failure and at various points on the circumference of the tube. From this study and parallel tests on parent metal put through differing heating and quenching cycles it was possible to determine the extent of overheating of the tube at the time of failure. The data are presented in the form of curves for probable quenching temperature of a 0.13-0.15% C boiler tube *vs.* Brinell hardness, and a hardness survey of the failed tube can be referred to the curve to determine the temperature attained in the region of failure. The numerous microstructures recorded for the heating and quenching cycles of the parent tube metal and for various sections of actual tube failures are illustrated for purposes of comparison. The examination of a large number of failed tubes by the Navy has shown the presence of Fe_3O_4 adjacent to tube failure, and wherever there is simultaneous evidence of no change in microstructure in the failed region, the conclusion is that the temperature attained by the tube was between 750° and 1333° F. since Fe_3O_4 does not form below 750° and no change in microstructure occurs until the critical temperature has been attained or exceeded. The presence of Cu deposited from water inside the tubes is commented upon, and its probable effect in increasing the corrosion of iron tubing discussed from evidence in the literature on both affirmative and negative sides. Some tests on the effect of pH of boiler water on Cu deposited are tabulated from Navy data showing lack of relationship, with the conclusion that Cu in boiler system is ineffective in promoting Fe corrosion. WB (11)

Nickel-free Corrosion Resistant Chromium Steels in Chemical Industry (Nickelfreie, korrosionsbeständige Chrom-Stähle im chemischen Apparatebau) E. BAERLECKEN. *Dechema Monographien*, Vol. 10, 1939, pp. 78-86. Original research. Deals largely with Cr steels containing 15-20% Cr, and more than 0.1% C. Data are given comparing the corrosion resistance of 18/8 and 17% Cr steel in HNO_3 of 4 different concentrations. The differences are small. It is admitted that 18/8 is superior in many cases but that the Cr steels are frequently safely applicable. Additions of Mo improve the corrosion resistance several-fold in certain media, particularly in solutions of HNO_3 and its salts, phosphoric, acetic, tannic, lactic and fatty acids. In fatty acid (230° C.), a 1.5% Mo, 17% Cr steel is superior to 18/8. Mo added to the latter also causes a notable improvement. By using low hot working temperatures, the undesirable grain-coarsening of the ferritic Cr steels may be avoided. Intercrystalline corrosion occurs in both 18/8 and Cr steels, but the corrosion resistance of both can be restored by heat treatment. Photographs are shown of 10 samples of Cr steel made subject to intercrystalline corrosion by holding at 1000° C.; samples re-annealed at 650°-800° C. again became immune. Carbide precipitation is eliminated by additions of Ta, Ti, Cb. Electric welding with austenitic welding rods is recommended. Oxyacetylene welding furnishes welds inferior as to mechanical properties. Although Ni-free steels of the Cr, Cr-Si, or Cr-Al types have been successfully employed as heat-resistant materials, only the Ni-free Cr steels have been applied in cases calling for corrosion resistance. EF (11)

Relations Between Crystal Structure and Corrosion. GERHARD DERGE (Carnegie Inst. Tech.) *Trans. Electrochem Soc.*, Vol. 75, 1939, Preprint No. 23, 13 pp. Review, plus original research. The surfaces of metals have a preferred orientation which may have an important influence on the initial stages of corrosion. For example, the different faces of a Cu crystal are dissolved or oxidized at unequal rates, and the rate of attack of Mg grains depends on the orientation of the crystals with respect to the surface. The concept of a superlattice in metals is discussed in connection with the parting limits of alloys and the catalytic effects of metals. Crystal orientation is shown to be an important factor in corrosion at grain boundaries, in the corrosion of metals with internal strains, in the corrosion of polished surfaces, and of two-phase alloys. The author gives some new examples of the relationship between crystal structure and corrosion. (a) On rusted, high purity iron, the geometric pattern of the rust varied with the orientation of the grains. (b) The corrosion of a tin-tube (contained 1% Cu) used as a toothpaste container was shown to be initiated by particles of Cu or a metallic Cu compd. (c) The grain boundaries of tin were more resistant to corrosion in a Na_2CO_3 solution than the bulk of the material, and therefore, corrosion was least in fine-grained material. AB (11)

Alloy Bearing Corrosion Problem Yields in Laboratory Attack. F. L. MILLER (Standard Oil Development Co.) *Nat. Petroleum News,* Vol. 31, Mar. 22, 1939, pp. R-102-106. Descriptive. Bearing corrosion troubles in automotive engines using the harder alloys to withstand increased bearing loads have been and are being decreased by the following developments: (1) Development of the new "sandwich" bearing and other new types, or treatment of present bearings with In (or other special treatment) to render them less susceptible to corrosion. (2) Improvement of engine design to make them run cooler and to lighten bearing loads and strains. (3) Proper selection and refining of the crude oil. (The rumor that corrosion troubles were associated with the solvent extraction process has been shown groundless). (4) Use of corrosion inhibitors in the oil. Data are given from a series of car tests run on a chassis dynamometer at 70 m.p.h. with road load and later engine dynamometer tests. A pronounced effect of engine operating conditions was found. Corrosion occurred only when engine operating conditions, either temperature, speed or load, or combinations of these, were severe. The used crankcase oils showed the development of considerable acidity and saponifiable material. Corrosion occurred only with those metals, Cd in the Cd-alloy bearings, and Pb in the Cu-Pb and Satco bearings. These metals react readily with organic acids to form soaps that are relatively soluble in mineral oil. The age of the engine influences the time required to obtain corrosion, this tendency becoming less as the engine becomes worn. Temperature was found to be very important, the critical temperature at which a medium corrosive oil and a less corrosive oil caused the same amount of corrosion being rather sharply defined. VVK (11)

The Effect of Cold, Aqueous Ammonia Solutions on Aluminum Sheet of Normal and Higher Purity (Ueber die Einwirkung kalter wässriger Ammoniaklösungen auf Aluminiumblech normaler und höherer Reinheit) H. RÖHRIG & J. ROCH. *Aluminium,* Vol. 21, Feb. 1939, pp. 128-130. Original research. Systematic tests were made to determine the attack of NH_4OH on Al of 99.5 and 99.99% purity. They show that in both cases the attack is strongest with 5% NH_3 content and that the attack by dilute solutions is more than by higher concentrations. The dissolving velocity of 99.5% Al was in all concentrations (for short time periods) greater than that of the very pure metal under similar conditions; but after longer time periods, the rate of solution of the "normal" product became less than that of 99.99% Al. The attack of 99.5% Al stops, in all solution concentrations, after the second day, while that of 99.99% Al increases gradually, especially in medium concentrations. The strength of the attack is determined by the formation of a deposit of aluminum hydroxide; if this deposit is dense, of fine grain and firmly adherent, it exerts a considerable protection, which, however, is appreciably reduced if the deposit becomes coarse grained and brittle. The tendency to formation of such coarse-grained deposits is greater on 99.99% Al than on less pure Al. It seems that the impurities, especially the Si, favor the formation of a fine-grained aluminum hydrated oxide. Ha (11)

Corrosion Fatigue in Aluminum and Magnesium Alloys (Untersuchungen über die Korrosionsermudung von Aluminium- und Magnesium-Knetlegierungen) F. BOLLENRATH & K. BUNGARDT. *Z. Metallkunde,* Vol. 30, Oct. 1938, pp. 357-359. Al-rich alloys with Mg or Mg and Si, and Mg-rich alloys with Al and with Mn were immersed in 3% NaCl solution during fatigue tests. The alloys had received a number of different heat treatments as well as cold work. The best values were shown by an Al alloy containing 8% Mg and 1% Zn that had been air-cooled from 420° C. The Mg alloys were the poorest. Micrographic study showed that corrosion occurred at the segregations resulting from the primary structure rather than at the grain boundaries of the recrystallized material. GD (11)

Some Tests of Acid-resistant Pipe. R. D. LEITCH. *U. S. Bur. Mines Rept. of Investigations* 3426, Dec. 1938, 7 pp. Experimental. Most pipes except plain steel, Cu-steel, and possibly wrought Fe are satisfactory in mine waters containing up to 700 p.p.m. total acidity. Up to 2,000 p.p.m., all but the foregoing and a chromized pipe were suitable. For use in water of unusually high acidity, say 10,000 p.p.m. or more, some cement-lined pipes with or without protective coatings, some rubber-lined pipes, Cr-Fe, some asphalt coatings, impregnated fiber, and coated cement-asbestos pipes are most likely to prove satisfactory. In these tests, a life of more than 2 years under extreme conditions was considered satisfactory. AHE (11)

A Study of the Chemical Stability of Nickel-copper Alloys (Zur Kenntnis der chemischen Beständigkeit der Nickel-Kupfer-Legierungen) W. CLAUS & I. HERRMANN. *Z. Metallkunde,* Vol. 31, Feb. 1939, pp. 55-59. Experimental. Potential measurements have shown that with up to 90% Ni the Cu-Ni alloys show the behavior of Cu. Weight loss measurements in sulphuric, hydrochloric and phosphoric acids, and synthetic sea water of various concentrations indicate the same general behavior. For practical purposes, the composition of many Ni-rich alloys could be lowered to about 30% Ni. GD (11)

12 General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

The Shape of Iron Deposits Resulting from Thermal Dissociation of Iron Pentacarbonyl in the Gaseous Phase (Abscheidungsformen des Eisens bei der thermischen Zersetzung von Eisenpentacarbonyl in Gasphase) D. BEISCHER. *Z. Elektrochem.,* Vol. 45, Apr. 1939, pp. 310-313. Review plus original research. Iron carbonyl dissociates into Fe (as deposit on the retort wall) and CO at 140° C., and under contact with metallic Fe at 60° C. At about 180° C., Fe is formed in the free space as fine particles suspended in the gas. Two particle shapes occur, thread-like and spherical. The thread shape is always obtained when operating below 700° C. with high dilution of the carbonyl gas in an inert gas and with quick removal of the reaction products. For the formation of spherical particles, high concentration of gaseous carbonyl in the dissociation zone is favorable. In production work, the carbonyl is introduced in the form of vapor or finely dispersed liquid into a cylindrical vertical furnace and Fe is continuously removed at the bottom. The temperature used in the experiments ranges from 200 to 600° C. Before the run, the retort is purged with N_2; later, it is either shut off or reduced to a small flow. No difference results from using Ar, H_2 or CO for purging. When using a flow in excess of 25 l./hr., more and more thread-shaped particles are obtained. The spherical particles obtained in the experiments have the same characteristics as those obtained by commercial dissociation. The diameter is 10^{-3} to 10^{-4} cm., and changes only slightly with the dissociation temperature. Ground and etched with alcoholic HCl, the spherical particles show shell-like construction. 1% C content was found. For both shapes, the O content increases only very slowly when exposed to air. A theory to explain the development of the thread-like shape and the spherical shape with the shell structure is developed. 14 references. RPS (12)

Origin and Development of Stainless Steel. V. N. KRIVOBOK (Allegheny-Ludlum Steel Corp.) *Heat Treating Forging,* Vol. 25, Jan. 1939, pp. 24-27. In 1821, Berthier observed that alloys very high in Cr were much less readily attacked by acids than Fe. Faraday and Stodart worked with low-Cr alloys in 1822, but, as their corroding medium was dilute H_2SO_4, they concluded that Cr increased rate of attack. In 1872, Woods and Clark stated that a 30% Cr alloy with 1.5% W gave maximum resistance to corrosion by acids. Sir Robert Hadfield missed discovering stainless steel when he investigated 9% Cr alloys, because he used H_2SO_4 as a testing medium. Harry Brearley and Elwood Haynes are responsible for the beginning of the era of Cr-bearing stainless steels. Haynes' first experiment on Cr-Fe alloy was in Nov. 1911. Brearley conceived the idea of stainless Cr alloys while working for the British Admiralty, and his invention was used commercially for making cutlery in the latter part of 1914. General Electric Co. developed low-C, Cr-Fe alloys for lead-in wires of electric lamps during Sept.-Nov. 1911, and used such an alloy for turbine buckets in 1915. Firth-Sterling Steel Co. experimented with low-C, Cr-Fe in June 1914. Benno Strauss developed the austenitic Cr-Ni alloys during 1909-1913. Significant contributions were made during 1914-1917 by F. A. W. Armstrong (Si-Cr alloy) and C. M. Johnson. After the war, Hamilton and Evans, and the Wilde brothers developed commercial production of low-C stainless Fe by direct reduction from chromite. MS (12)

books

Spectrographic Analysis

SPECTROCHEMICAL ANALYSIS IN 1938. *By F. Twyman. Published by Adam Hilger, Ltd., London, 1938. Paper, 6 x 9½ in., 68 pages. Price $1.25.*

This booklet offers an excellent starting point for anyone wishing to acquire familiarity with spectrographic methods of analysis of materials, giving as it does brief explanations and numerous references which aid in assembling other useful guides. It is intended to be used in conjunction with the author's other books, "The Practice of Spectrum Analysis" and "Spectrochemical Abstracts 1933-1937," which it brings up to date. After summarizing progress in spectrochemical methods since 1933, the author discusses quantitative spectrochemical analysis with the microphotometer. Short sections follow on the causes of discrepancies between chemical and spectrochemical results on the same analysis, and on spark circuits. The remainder of the book—approximately half—is devoted to a brief presentation of the elements of the theory of atomic spectra, written by A. C. Candler.—G. R. HARRISON.

Heat Treatment

HEAT TREATMENT OF METALLURGICAL PRODUCTS. *By A. Portevin, Published by Penton Publishing Co., Cleveland, 1939. Cloth, 6 x 9 in., 246 pages. Price $5.00.*

This is an elementary text book, covering annealing, quenching and tempering of steel, malleabilization of iron, precipitation hardening of aluminum alloys, etc. Suggestions for a few laboratory experiments to illustrate principles are included. Attention is centered on the phenomena involved; data on particular steels are given only as examples of characteristic behavior, rather than for the information itself. The book is aimed for the student rather than the practictioner and for the beginner rather than the expert. Many important topics are brought in so casually that the reader will hardly grasp that they are important.

On first reading, the book does not seem very clear, the translator often uses words whose metallurgical connotation is none too obvious, and the style is now and then quite stilted. Because of this and because the price is high as prices per page of text books go, its wide adoption as the primary text book in a metallurgical course seems questionable, especially as the contents comprise only the principles that are set forth in any of many other texts.

On re-reading, after one has become accustomed to the style, the argument becomes clearer. A student who has studied some other text book could use this for review, as a test of his grasp of fundamental phenomena. If he can recognize in this other guise the identity of the principles with those to which he was previously introduced in totally different language, they may be more firmly fixed in his mind than if he had merely reviewed his original text.

It is a pity that so sound a book by so eminent an author is marred by the translation. Most readers will probably be repelled rather than attracted by the oddities of phrasing. With a better translation the book would be welcome, though not unique or indispensable. As it is, we'd rather have $5.00 than to have it on our shelves.—H. W. GILLETT.

Statistics

METAL STATISTICS, 1939. 32ND EDITION. *Published by American Metal Market, New York, 1939. Cloth, 4¼ x 6¼ in., 632 pages. Price $2.00.*

The same general assortment of statistical data on ferrous and non-ferrous metals and on miscellaneous economic subjects, contained in other annual issues, is found in this, the 32nd edition. Again there are, in this edition, numerous additions and alterations. For the first time there are found statistics on molybdenum, ferrosilicon and magnesite as well as new tables showing rolled steel "produced for sale," tin plate production by quarters and the output of drawn and barbed wire, etc. In non-ferrous metals there is a new series of monthly tables on domestic and foreign crude and refined copper statistics.—E. F. CONE.

STATISTICS OF THE IRON AND STEEL INDUSTRIES—1937. *Published by British Iron and Steel Federation, London, 1938: Cloth 7 x 9¾ in., 306 pages. Price 10s., 6d.*

To those interested in world statistics of the iron and steel industry this book is of decided value and authority. It is issued annually. There are 41 countries for most of which complete data on the production of the major iron and steel products is given for 1937 or the latest year for which statistics are available. Data also on exports and imports are included as well as other information. There will also be found a table on world production of pig iron and one of steel for the years 1866 to 1937 inclusive.

For those interested there is a Tariff Section giving the duty rates and tariff conditions in operation on Sept. 26, 1938.—E. F. CONE.

Panorama of Arc Welding

ARC WELDING IN DESIGN, MANUFACTURE AND CONSTRUCTION. *Published by James F. Lincoln Arc Welding Foundation, Cleveland, 1939. Cloth, 6 x 9 in., 1408 pages. Price $1.50 in U. S. A.; $2.00 elsewhere.*

This imposing volume contains the outstanding papers of the $200,000 award program of 1938 of the Lincoln Foundation. There are 109 original studies of welding by leaders in the several branches of the industry and they undoubtedly contain a large and valuable source of scientific study, research and information on welding. The book affords scientific and technical schools, colleges and universities, engineering schools, colleges and libraries, and others with a wealth of data on welding.

The contents are arranged as chapters of 10 sections. The various sections include: Automotive, Aircraft, Railroad, Watercraft, Structural, Furniture and Fixtures, Commercial Welding, Containers, Machinery, and Jigs and Fixtures. In these sections there are 109 chapters and 695 illustrations.

The volume is a valuable addition to the literature on welding and should be helpful to many working and interested in this broad field.—E. F. CONE.

Other New Books

LESSONS ON TESTING MATERIALS (Leçons sur les Essais de Materiaux. Pt. I, La Structure et la Deformation des Solides. Pt. II, Essais des Metaux). *By R. l'Hermite. Published by Hermann & Cie., Paris, 1938. Paper, 6½ x 10 in., Part I, 52 pages, price 18 Fr.; Part II, 73 pages, 21 Fr.* Accurate enough, but too hurried and skimpy.

COMBATTING CORROSION IN INDUSTRIAL PROCESS PIPING. *By L. G. Vande Bogart. Published by Crane Co., Chicago, 1939. Cloth, 7¾ x 10¾ in., 103 pages. Price $3.00.* Practical, thorough, concise treatment.

INDUSTRIAL TECHNOLOGY HANDBOOK (Betriebstechnisches Taschenbuch). *By H. Kotthaus. Published by Carl Hanser, Münich, 1939. Cloth, 4¼ x 6¾ in., 412 pages. Price 4.90 RM.* Too technical for the beginner, too superficial for the expert.

FOR MELTING METAL

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CURRENT news

Lukens Steel Licensed To Make "Ledloy"

The Lukens Steel Co., Coatesville, Pa., has been licensed to produce lead-bearing steels under the Inland Steel Co.'s Ledloy patents. Ledloy, produced by the open-hearth process, it is claimed to combine all the desirable properties of open-hearth steel with the free-cutting properties which permit from 50 to 200 per cent higher machining speeds. The lead content which by definition, is about 0.25 per cent serves the further advantage of lubricating the steel and lengthening tool life from 200 to 300 per cent it is stated.

Machine Tool Show

A 1939 Machine Tool Show, to be held in Cleveland October 4 to 13, has been announced by the National Machine Tool Builders Association. Both in number and range of exhibits and in improvements in performance and design of machine tools, this year's show is expected far to surpass the last one held in Cleveland in 1935.

The show will be housed in Cleveland's Public Auditorium, which contains over 6 acres of exhibition floors. Of this space, 150,000 sq. ft. will be taken up by the actual booths of exhibitors, ranging in size from 200 to 4000 sq. ft. 85 per cent of the exhibit space will be devoted exclusively to the showing of machine tools. The balance will contain displays of makers of machine tool accessories, and of publishers of magazines covering the machine tool field.

WANTED

1 Used Rockwell Hardness Tester Model 1R or 3R, in good condition.

BOX MA-143

All-Aluminum Sail Tried

G. Albert Lyon, Allenhurst, N. J., inventor and sailboat enthusiast, has developed a new wrinkle for those who find their fun on the bounding main.

But there's not the slightest trace of a wrinkle in the 310-sq. ft., all-aluminum sail which Lyon broke out this week on Barnegat Bay—a seamless, paper-thin sheeting mounted on thin ribs of the same metal atop a trim 18-ft. sloop.

Manipulation of the metal sail, pliable enough to belly out in the best manner of an orthodox balloon jib, is made easy by a steering wheel which resembles that of an automobile. The sail and mast are mounted on a turntable, which permits movement of the sheet up and down and sideways.

Lyons says no wind can pass through the sail, that it is easier to control than canvas, assures even speed, is more durable than canvas and holds "skin friction" to a minimum. —N. Y. Times, July 9.

New Fellowship in Metallurgy At Carnegie Tech

Industry and education forged another link in their chain of coordinated research and training with the announcement by Carnegie Institute of Technology of a Westinghouse Fellowship for graduate study in metallurgy. Dr. R. F. Mehl, director of the Metals Research Laboratory and head of the Department of Metallurgy at "Tech", said the fellowship would continue for a 3-yr. period and provide $1,200 a year to the recipient for graduate study and research in metallurgy.

Frederick C. Hull, of Ann Arbor, Mich., a graduate of the University of Michigan in 1937, has been selected as the first Fellow under the plan. During 1939 and 1940 he will continue the studies in reactions of steel, which he has been pursuing for the past 2 yrs. as a teaching assistant in the department of metallurgy.

In addition to the Westinghouse award, similar fellowships have been recently established at Carnegie by the International Nickel Co., the Aluminum Co. of America, the Molybdenum Corp. of America, and the Unitcast Corp.

● Air Reduction Sales Co., 60 East 42nd St., New York, announces the appointment of J. T. Gillespie, Jr. as assistant to Thomas B. Hasler, president of the Wilson Welder & Metals Co., Inc., an affiliate of Airco. Mr. Gillespie, whose headquarters will be in New York, was formerly assistant manager of the central division of railroad sales of Air Reduction Sales Co., in Chicago.

Rapid Annealing of Wire

A new continuous process, which is claimed to anneal wire up to 1000 ft. per min., has been developed cooperatively by the Surface Combustion Co., Toledo, and the Synchro Machine Co., Newark, N. J. It is undergoing test runs on copper wire. A part of the essential apparatus consists of accurately controlled gas flames arranged in a row 9 ft. long, with positioning dies spaced along the length of the row to ensure the passing of the moving strand of wire through the exact portion of each flame, where the temperature and the composition of burning gas are "just right." Later on the row of flames may be increased to 27 ft. to permit higher annealing speeds.

A feature of the apparatus is an indicating "anneal meter" which it is described, "feels the texture" of the annealed wire's surface as it leaves the annealing burner and regulates automatically the speed of the oncoming wire. The new equipment may be used, it is pointed out, for annealing alone, or for pickling and coating (principally tinning), in which case suitable acids and inhibitors and coatings are sprayed on as the wire glides by. Claims for the new development are not only speed, but space-saving and a uniform anneal.

Steel In Sporting Goods

Steel is more prominent today than ever in sports and games says the American Iron and Steel Institute, and every year millions of pounds of steel are bought in the form of sport and recreation equipment. When many modern sports were developed, wood and leather were used widely, but the trend is now toward steel where speed, strength and safety are important.

Golf, a game in which little steel was once used, last year absorbed about 1,069,000 lbs. in the manufacture of new golf clubs, exclusive of other uses on the golf courses. Of the total for golf clubs, 175,000 lbs. of steel were used for the shafts of wood-headed clubs, while 894,000 lbs. were used for the shafts and heads of irons.

● Carroll H. Henkel, metallurgist and chemical engineer, has recently joined the research staff of Battelle Memorial Institute, Columbus, Ohio, and has been assigned to the non-ferrous metallurgy division. He will be engaged largely in problems related to tin and its uses. He has had wide experience in pickling and tinning problems, both of a developmental and industrial nature. Mr. Henkel is a graduate of West Virginia University and a member of the American Institute of Chemical Engineers.

● Richard P. Brown, who was recently appointed by Governor Arthur H. James to be the first Secretary of the new Department of Commerce of the Commonwealth of Pennsylvania, is known as the former president and now chairman of the board of the Brown Instrument Co., Philadelphia and vice-president of Minneapolis-Honeywell Regulator Co.

● Beginning in September, Alexander R. Troiano will become assistant professor of metallurgy in the University of Notre Dame, replacing Carl F. Floe who has resigned to assume similar duties in Massachusetts Institute of Technology. Professor Troiano received the degree of D.Sc. in Metallurgy from Harvard University in June, 1939.

● Morris E. Leeds, founder and president of the Leeds & Northrup Co., Philadelphia, has assumed the position of chairman of the board of directors, and Charles S. Redding, vice-president in charge of research and engineering, becomes president, in an expansion of the company's executive set-up, effective July 10.

● In keeping with the recent reduction in the price of silver, Handy & Harman, New York and Bridgeport, Conn., announced July 6 a revised schedule of prices for their brazing alloys, "Sil-Fos" and "Easy-Flo." Sil-Fos is now 20c per lb. lower and Easy-Flo has been reduced 3½c per troy ounce.

+SPEED CASE+ IS WORLD'S FASTEST MACHINING O.H. CASE HARDENING STEEL

Firth-Sterling Takes Over "Cutanit"

The Firth-Sterling Steel Co., McKeesport, Pa., has acquired the American Carbide Alloys Corp., with equipment and stocks of finished and raw materials at Lewistown, Me., and Detroit, along with exclusive U. S. rights for the manufacture of "Cutanit", a cemented titanium carbide alloy.

Development of this cutting material in Europe has paralleled the increase in armament production, since its use in cutting tools has lent tremendous impetus to the manufacture of big guns, rifles, shells and other war materials. Its use has grown from 9,900 lbs. in 1935 to 44,000 lbs. in 1937, the last year for which figures are available. The McKeesport firm is internationally known as a maker of high-speed tool steels and as a pioneer in the production of tungsten carbide cutting tools.

Gold Medal to Dr. Wesley

Dr. W. A. Wesley, of the International Nickel Co.'s research laboratory at Bayonne, N. J., was awarded the annual gold medal of the American Electro-Platers Society, at the 27th annual convention of the society at Asbury Park, N. J., in June. The award was made in recognition of his paper on "Physical Properties and Uses of Heavy Nickel Deposits."

● Wilbur B. Driver Co., Newark, N. J., manufacturers of "Tophot" resistance wire, is having an exhibit at the New York World's Fair, in the Metals Building directly opposite the trylon. The exhibit features the various stages of the manufacture of "Tophot" from the ingot as cast to the finished material. There will also be shown numerous finished products in which "Tophot" is used.

Students for Scholarships

Carnegie Institute of Technology, Pittsburgh, in cooperation with the Westinghouse Electric & Mfg. Co., has begun a search for the second group of 10 boys who will be trained as engineers under a 5-yr. "work-learn" study program, made possible by the Westinghouse company in conjunction with its $200,000 appropriation to the Institute in 1937.

The cooperative engineering educational plan, which enables the student to obtain practical experience in Westinghouse plants during five summer vacations and two college semesters as well as to complete eight semesters of college class work, was launched last summer with the selection of the first 10 scholarship students.

When in complete operation, the scholarship courses will include 50 students, with 10 scholarships becoming vacant every summer. Each scholarship has a value of $3,000 and is awarded to a student of exceptional ability, final selection being based on results of competitive examinations, character and personality.

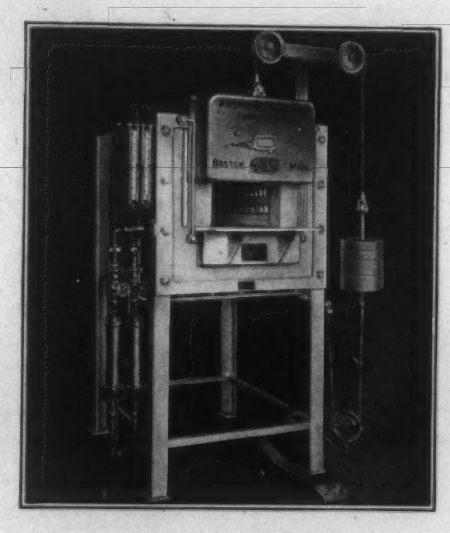
Blood and Stainless Steel

A certain customer, who uses Iwell steam vessel blood dryers, found that the action of the blood pitted and destroyed the inner mild steel liner at seams and joints. Some years ago he bought from Edgar Allen & Co. Ltd., Sheffield, England, a number of "Maxilvry" stainless steel beater plates for experimental use in the dryer. These plates were recently examined and found to be unaffected. While this constitutes an excellent testimony to the corrosion-resisting properties of Maxilvry stainless steel, one might conclude, in Shakespeare's words: "This is indeed a bloody business."

"AMERICAN" ELECTRIC Controlled Atmosphere FURNACES

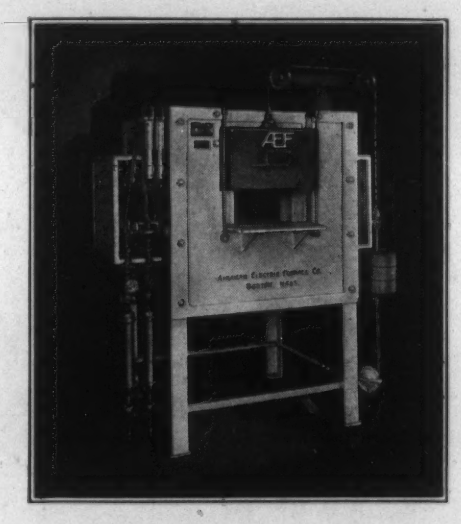
PREVENT ..... Scaling Burning Decarburization

REDUCE ..... Dimensional Change Grain Growth



B-20 FURNACE
Chamber 12"x24"x10"
for
Preheating, Hardening, Annealing

Model B "AMERICAN" Electric Furnaces are designed primarily for general heat treating operations up to 1900° F. They are particularly suited for preheating high speed steels where atmospheric control is essential.
These furnaces completely satisfy the variable demands of the tool room as well as the requirements of the production line for long life, low upkeep, and positive results.



HB-10 FURNACE
Chamber 8"x12"x5"
for
Heat Treating High Speed Steel

Model HB "AMERICAN" Electric High Speed Furnaces are designed particularly for the high temperature operation required by high speed steels and are adapted for practically any heat treating process between 1900° and 2500° F. They are equally well fitted for use in the tool room with its infinite variety of work or in the production line where quantity is paired with quality.

"AMERICAN" Atmospheric Control as incorporated in "AMERICAN" controlled Atmosphere Furnaces provides full 100% control of the curtain across the door opening and the atmosphere which surrounds the work. Atmospheric control is equipped with dehydrating cylinders for removing moisture from air and gas. Curtain is automatically synchronized with door opening.

U. S. Patent Nos. 1,357,790, 1,399,638, 1,652,200, 1,819,554.

ASK FOR BULLETINS 42 and 25.

American Electric Furnace Company

29 Von Hillern St. **Boston, Mass.**

All types Industrial Furnaces

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Physical metallurgist, age 22. B.S. degree, electrochemical engineering, M.I.T., 1938. Brief experience in melting, casting, silver soldering, and cold working of precious and other non-ferrous alloys, metallographic work, and wet assaying. Experience in deposition of metallic films in vacuo. Starting salary secondary. No locational preferences. Box MA-149.

POSITION WANTED: Young metallurgist, married, with several years experience in powder metallurgy research, including compacting, heat treating, and working of ferrous, non-ferrous, refractory and lubricating alloys. Competent analytical metallographer. Wishes to continue more extensively in the research and development of metal powder products. Best of references. Box MA-150.

POSITION WANTED: Metallurgical engineer, 27, single, B.S. '37, Met.E. '38. Experience: Worked six months in copper smelter as helper in smelting department; also six months as research metallurgist in non-ferrous laboratory; laboratory testing, metallographic examination, testing of high melting refractories, assaying. Desires position with an industrial organization. Available immediately. Box MA-151.

POSITION WANTED: Chemical engineer. One year experience as powder metallurgist, dealing with hot compression of powdered carbides. Half year experience as research assistant to professor of large Eastern university. Trained analyst. Available immediately. Single, 25, Eastern location preferred. Box MA-152.

Now Ready

THE CUMULATIVE INDEX OF METALLURGICAL ABSTRACTS FOR 1938

DURING 1938 METALS and ALLOYS kept its readers informed of current world-wide developments in metallurgical practice and science with a total of 3,984 abstracts and 100 book reviews. This metallurgical reader's digest covers published information on both ferrous and non-ferrous metallurgy. It has been of inestimable value to engineers, executives and scientists who try to keep abreast of the avalanche of new information issuing constantly from all quarters of the globe.

The Cumulative Index is a surprisingly handy classification of all the information published in the Abstracts Section last year. It is convenient to use, as a direct result of the care and metallurgical understanding that went into its preparation.

●

All the articles on a given subject will be found in *one* place in the index . . . and nomenclature variations, inversions and synonyms have been carefully cross-indexed to refer to this main entry. Where an article featured more than one topic, all have been indexed. Studies of alloy systems have been indexed separately under each constituent. No effort has been spared to make this the most useful guide to new metallurgical information that we could place in your hands.

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USE THE CUMULATIVE INDEX FOR PERMANENT, CLASSIFIED REFERENCE TO ALL THIS INFORMATION.

trends

By Edwin F. Cone, Editor

Austempering

One of the most important trends in the field of heat treating is the austempering process, developed by the U. S. Steel Corp.'s metallurgical engineers. We feel proud to be able to publish the first complete presentation of the industrial or commercial phase of this process as our leading article in this issue. Undoubtedly its use will spread for it is highly adaptable to certain products.

Alloy Steels

Our analysis in this issue of the trend in alloy steel output for 1938 is not as favorable as in past years. There is, however, only a minor lapse in the upward trend. Of interest, however, is the fact that the percentage of stainless steels of the total alloy steel production was at a new high last year—5.82 per cent in 1938 against 3.10 per cent in 1934.

Electric Steel

Production of steel in electric furnaces is increasing, particularly in the alloy field. Our analysis of official data in this issue shows that, of the total alloy steel made last year, the proportion made in electric furnaces at 22.5 per cent was the highest ever recorded. At 19.8 per cent in 1937 a new record was made.

Scrap to Japan

Agitation from several quarters is in evidence to limit in some way scrap iron and steel exports. Several Congressmen are considering some such legislation. It is high time when it is realized that in the last 75 months, or from January, 1933, to April 1, 1939, over 14,500,000 gross tons of American scrap has been exported of which Japan has taken 7,772,000 tons or about 53.5 per cent! Italy is second.

Pearlitic Malleable

The study of and the experience in making and using pearlitic malleable are so much on the increase that the committee of the A.S.T.M. handling malleable iron is preparing up-to-date specifications for pearlitic malleable. The welding of malleable is also making rapid strides.

Round Table Discussions

The trend toward more round-table discussions or luncheons seems positive. We were impressed with this fact during attendance at the A.F.A. and A.S.T.M. annual meetings in May and June. The foundrymen are enthusiastic users of this method. Among several at the testing society's meeting were two of decided importance: Spectrographic Analysis, and Metals at Sub-Zero Temperatures. Both of these are to lead to symposia, thus adding much to the literature.

Convention Badges

This is not a trend but we feel it should be. At the annual meeting of the A.S.T.M. in June, personal registration badges were printed in fairly large type. We feel that this should be the universal practice—particularly the person's name. We hear frequent statements as to the inability of one to recall a name (we too often experience this) with consequent embarrassment. Ability to at once see the name is decidedly helpful.

A.S.T.M. Standards

The excellent work of the standardizing committees of the A.S.T.M. continues—the number of specifications mounts. At the annual meeting in June, Committee E-10 on Standards reported that there are now 505 standards and 365 tentative standards or 870 in all. If all recommendations current at the convention were adopted, the total became 875.

Alloy Malleable Iron

We are informed by an authority, closely associated with the malleable iron industry, that alloys are playing a more important role than heretofore. Castings are being made using copper and molybdenum which, with proper heat treatment, are said to have highly desirable properties.

Stainless Steel

According to *Steel Facts*, published by the American Iron and Steel Institute, more than 3200 tons of stainless steel has been consumed in the construction of 30 stainless steel streamlined trains now in use on American railroads. Taking into account orders now on hand, (June) about 3750 tons will soon be in service. The trend in the consumption of stainless steel for this purpose has been and is an outstanding one in recent years, and bids fair to increase.

Flame Hardening

We have received an impressive photograph of a flame hardening operation which is said to be the largest of its kind successfully completed. It was done by the oxyacetylene process. It was a carbon steel lathe spindle, 63 in. in diam., whose surface was thus hardened. The trend in the use of this comparatively new development is rapid.

Coined Trade Names

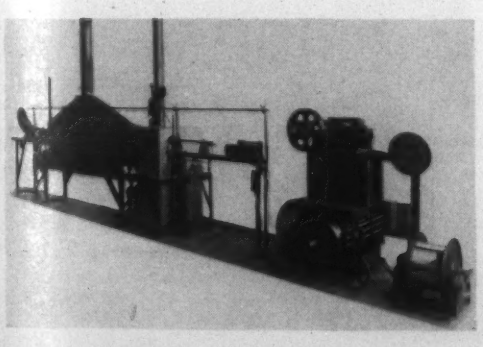
Another instance of the glaring tendency to coin unusual, and sometimes unusable, words is the recent announcement of "Ar-Ma-Steel." This name comes from a special heat treatment of malleable iron which is claimed to give a metal, designated "arrested malleabilized steel," resulting in castings with strength and reliability similar to forgings.

New Equipment and Materials

Annealing and Tinning Copper Wire in Strands

The bright annealing and tinning of copper wire continuously in strands has been made practical through a new joint development by the Syncro Machine Co., New York, N. Y., and the Surface Combustion Corp., Toledo, Ohio. The wire is unwound from the spool, passes over a push-pull capstan, through a mechanical cleaner, and then through an annealing chamber. For tinning, the wire then passes through a chlorine fluxing agent. Fluid tin is uniformly applied under pressure by means of a unique construction of jets. The tin is entirely enclosed, reducing oxidation losses to an absolute minimum. Excess tin is retrieved and the wire burnished to a high luster as it leaves the tinning zone, by a self-cleaning wiping device.

Quenching takes place in circulating water, the excess water being removed by a highly



efficient vacuum wiper. The wire then passes through a visual indicator which constantly shows and regulates the degree of anneal. This device makes possible extremely accurate and uniform control in obtaining the desired percentage of elongation.

The take-up is motor driven and provided with a traverse. The spool drive automatically maintains correct tension throughout the filling of a spool. The spooling tension can be adjusted while the unit is in operation. The unit can be used for either tinning or straight bright annealing. The annealing chamber consists merely of special open-flame burner with a sheet metal hood as a protection against drafts.

The flame is continuous and up to 27 ft. long depending on the gage of the wire. The burner is specially constructed to produce a flame of uniform height along its entire length. The wire is carefully guided through the reducing portion of the flame so as to eliminate oxidation. This principle of bright annealing is the same as used on the large continuous direct-fired furnaces for annealing wire in coils and in which the burners are set slightly rich so as to produce a reducing atmosphere.

The elimination of an expensive furnace and other contributing factors makes this method of annealing or annealing and tinning copper wire, drastically cheaper than any other method. Several installations have been made to date.

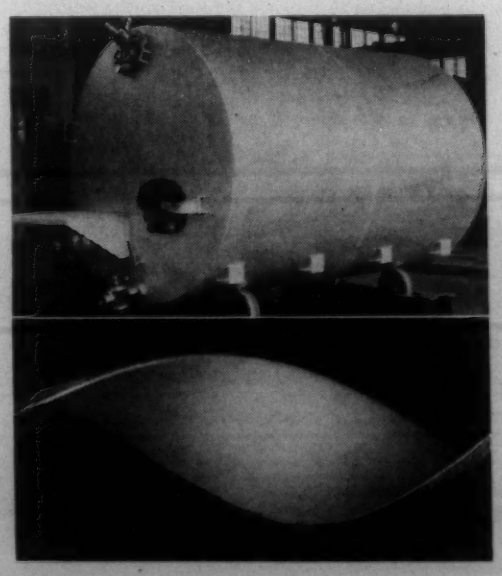
Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts not more than 2 in. wide.

"Silver-Ply" Stainless Clad Steel

Stainless clad steel sheets and plates, known as "Silver-Ply," which combine the corrosion resistance of stainless steel with many of the desirable properties of mild steel, are now being marketed by the Jessop Steel Co., 546 Green St., Washington, Pa. They are said to be suitable for cooking vessels, storage tanks and other equipment used in the processing and handling of materials wherever corrosion or erosion are encountered.

Silver-Ply may be bent, spun into deep heads, deep drawn, drilled and otherwise worked with greater ease than solid stainless. Furthermore, it is claimed to have better heat conductivity than solid stainless and is not subject to "hot spots"—an important advantage when used in the fabrication of cooking vessels. It is manufactured by a patented process which is said to assure a strong, uniform, oxide-free weld between the stainless cladding and the mild steel backing. Other claimed features of the process are close control of the relative proportions of the component parts, and prevention of carbon particles from migrating to the stainless cladding, which might otherwise seriously reduce its corrosion resistance.

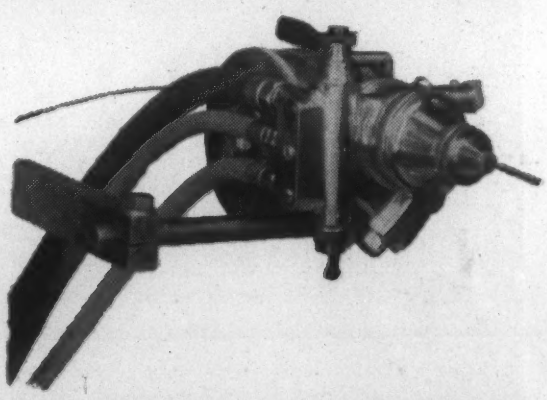
The usual sheet or plate of Silver-Ply consists of 20% stainless steel and the balance mild steel, ordinarily of flange quality; however, all degrees of cladding from 3 to 50% have been successfully produced, it is stated. Complete information and copy of specifications will be sent upon request.



Improved Metal Spraying Gun

The "Mogul Metallizing Gun" is offered by the Metallizing Co. of America, Inc., Los Angeles, Cal., and is designated as Model P. It is complete with handgrip and toolpost attachment (interchangeable) extra air cap and nozzle for ⅛-in. dia. wires, with jar of valve lubricant, jar of gear case grease and so on.

It is claimed by the company to be the finest metal spraying tool ever produced. It is claimed that it has been used in every type of service under all operating conditions, and that hundreds of users attest to its superior perform-



ance. There are said to be no worries of wire stoppage, and that the turbine is extremely powerful and will lift a 75-lb. weight. It operates hour after hour without adjustment troubles and burning out of tips has been eliminated. All shafting is made of steel, hardened and ground to size. The counter shaft, as well as all the other shafts enclosed in dirt proof case, are mounted on annular bearings. Perfect shaft alignment is maintained and freedom from bearing troubles assured. There is a one valve control that automatically mixes all gases making for simplicity in operation.

A Baking Enamel Reproduces Metal Colorings

A new baking enamel, which reproduces the colors of many metals, has been developed by Maas & Waldstein Co., makers of industrial finishes, Newark, N. J. With this enamel, which is known as "Baking Platelustre", any polished metal can be made to resemble brass, chemically treated aluminum and steel, and other colored metals, according to the manufacturer. It is very durable when baked, and will then resist the action of cleaning operations and also nickel, chromium and other plating baths so that, when applied sectionally, a wide variety of effects is made possible. Flat stock finished with this enamel can be formed after baking. Two-color finishes can be obtained by "relieving" operations.

Baking Platelustre can be applied to any kind of polished metal by spraying or roller coating. It is especially suitable for compacts, novelties, lighting fixtures, and other products where a brilliantly colored metallic finish is wanted.

Elevator Type Automatic Plating Conveyor

A distinctly new type of full automatic plating conveyor has been perfected by the Hanson-Van Winkle-Munning Co., of Matawan, N. J. This machine, called the "Elevator Type Conveyor", is suitable for almost any of the wide variety of plating and coloring operations. The conveyor is of the dwell type, having carriers mounted in their own guides, moving freely up and down. The guides are permanently attached to chains, top and bottom, at fixed spacings. The carriers advance one station whenever the conveyor chain moves forward the distance of the carrier spacing. A counter-balanced elevator, sliding on vertical guide tubes, moves up and down through a fixed distance, engaging the carriers at the transfer points. During the top position of the transfer the horizontal chain moves forward one carrier spacing before the elevator is lowered. Outstanding advantages claimed for this conveyor are its simplicity, low headroom and wide range of applications.

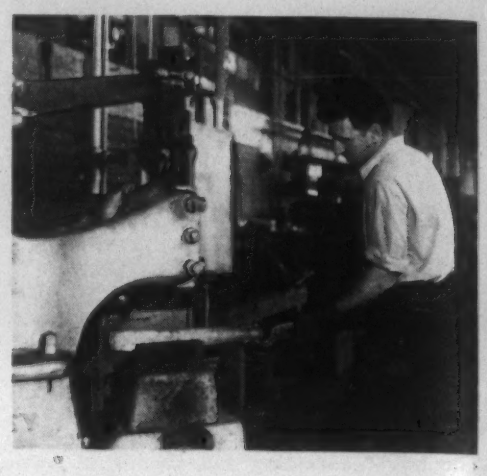
Tube Mill Machinery

The industrial equipment division of the Continental Roll & Steel Foundry Co., East Chicago, Ind., has acquired the Howell Engineering Co., of St. Charles, Ill., in which to manufacture the welded tube mill machinery made under the B. F. Bower patents and patents pending, and recently placed on the market by them. The engineering, service and sales staffs have become part of the Continental organization.

Included in the Continental line of tube mill machinery are high production welded tube mills which produce tubing in a wide range of diameters from flat stock at speeds up to 60 ft. per min., delivering tubes of any predetermined lengths by means of a flying saw; hydraulic tube bending machines for bending unfinished tubing to any desired angle without crimping or marring the surface; and tube buffing and polishing machinery which continuously and automatically buffs and polishes either straight or tapered tubing.

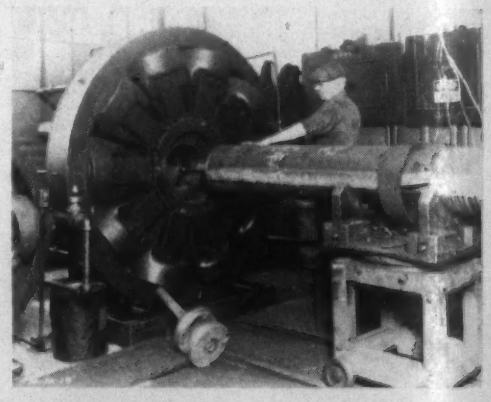
Flat Work Ironer Rolls

The American Laundry Machinery Co., Rochester, N. Y., has developed an interesting fabrication method used in the production of flat work ironer rolls. These rolls consist of steel pipe with outside diameters ranging from 2½ to 12 in. and with lengths up to 120 in. Construction details require the rolls to be fitted at both ends with a steel shaft by means of which motive power may be applied to them. The method of fabricating and fitting these shafts is claimed unique, involving the forging

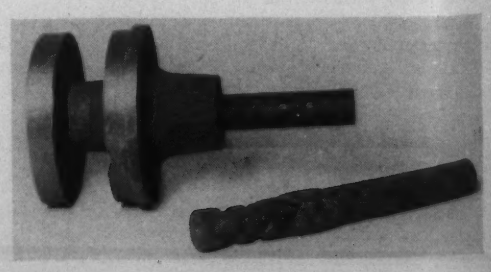


of the shafts, casting Meehanite gudgeons on to the shafts, and the tight and permanent fitting of the shaft and gudgeon into the pipe ends.

Bessemer steel shafts 2¼ in. in diameter and 2 in. long (used on the larger rolls) are cut from bars and centered. The shafts are then forged with a die under a drop hammer. The forged shafts are sent to the foundry, placed



in dry sand molds, and about 139 lb. of Meehanite Metal are poured on to it, forming a gudgeon. Gudgeons are then turned down to size to allow them to enter the steel pipe, after which the combined gudgeon and shaft are placed in the pipe which, in turn, is compressed by means of a "West" tire setter making a tight and permanent fit. Both pipe and gudgeon shafts are then turned in the lathe prior to assembling the ironing machines.



A Rubber Moulding Process for Metal Castings

The Alrose Chemical Co. of Providence, R. I., has developed and standardized for the first time a complete, low cost process for producing white metal castings with rubber molds. Quality castings of fine detail and smooth texture can now be produced, it is claimed, without blow-holes, on a production basis. This new process replaces expensive bronze molds and produces from 15 gross to 100 gross of castings from a mold costing less than $5.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 7 of a Series

IN THE BALMAT LABORATORY

WEIGHING SAMPLES

METALLURGICAL CONTROL is one of the most vital considerations in the mining, milling, smelting and refining of pure metals. This control actually begins underground at the Balmat and Edwards zinc mines of the St. Joseph Lead Company in northern New York, where selective mining and frequent sampling combine to provide the mill on the surface with a steady supply of uniform ore.

In the mill, samples are taken mechanically at each step of the process. Immediate analysis by the laboratory gives the operators complete control of the milling operations for each shift.

During the processing of concentrates at the Josephtown, Pa., smelter, for the production of metallic zinc, samples are taken at close intervals at all stages of manufacture, and each tap of metallic zinc from the condensers is sampled, analyzed and graded. In this way, not only the purity but also the uniformity of the zinc is rigidly controlled.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE
NEW YORK

ELDORADO 5-3200

PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

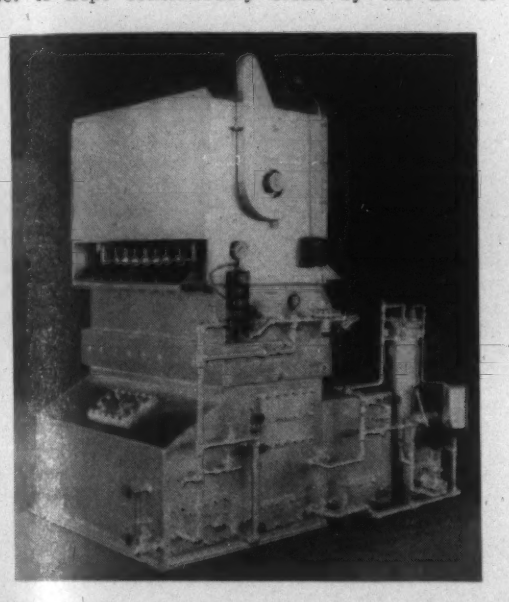
Vapor-Liquid-Vapor Degreaser

For the fully automatic, economical cleaning of cylinder shaped parts, such as the stators and rotors that are used in electrical refrigerators, the Detroit Rex Products Co., 13005 Hillview Ave., Detroit, has developed and placed on the market a "1-dip Detrex Degreaser." It is pointed out that it does not require any operator to handle the work.

The conveyor on this machine is a 2-strand type, equipped with pendant fixtures for carrying the work to be cleaned. The cylinder-shaped work is fed to the degreaser 6 units wide from a table equipped with guides, and the parts are released by a chain-driven indexed feed mechanism which allows them to roll on the pendant-type fixtures, these fixtures being rigidly guided in both the loading and unloading position.

The cleaning cycle consists of 2 min. in vapor, 2 min. immersion in boiling solvent, followed by 2 min. in the pure solvent vapors. As the work is carried out of the solvent vapors, it is clean, warm, and dry. At the exit position, the work is unloaded smoothly onto the unloading platform as the conveyor changes direction of travel and tilts the work fixtures. The loading and unloading tables are at opposite ends of the machine.

The solvent in the immersion boiling chamber is kept continuously clean by the use of



an auxiliary concentrating chamber, the return flow of pure distillate from the wide water jacket condenser to the immersion chamber, and a continuous operating filter applied to the immersion chamber for the complete removal of insoluble matter that is removed from the work.

The concentrating chamber, which can be seen extending out under the unload end of machine, is heated with steam coils which are welded to a removable clean-out door. The clean solvent immersion chamber, which can be seen on the lower center section of the illustration, is heated by a steam jacketed bottom, equipped with a pressure relief valve. Both the concentrating and immersion chambers have access doors, clean-out doors, gage glasses, and drain valves. The condensate from the collecting trough inside the machine beneath the water jacket condenser can be piped either to the immersion chamber or the clean solvent storage tank, of sufficient capacity to hold all of solvent from machine during distillation.

A motor-driven solvent transfer pump is used to transfer solvent from drum to machine, from storage tank to immersion chamber, and to continuously circulate the solvent from the immersion chamber through the continuous filter. The degreaser is equipped with a direct acting, self-actuated vapor level control, bypass piping, valve, strainer, steam gage, and steam pressure reducer.

This design is manufactured in various sizes depending on production requirements; the machine shown having approximate overall dimensions as follows: Length, 6 ft. 2 in.; width, 6 ft.; height, 8 ft. 10 in. Work clearances are designed to accommodate 6 rotors or stators per fixture, the fixtures being adjustable to take care of various widths. The 2-strand conveyor has 17 pendant type fixtures spaced at approximately 9⅞ in. centers. The conveyor is complete with motor drive and speed reducer. The approximate weight of the degreaser is 3,000 lbs. At a conveyor speed of 8 in. per min., this degreaser is claimed to clean 300 parts per hr. or a production rate of 3,000 lbs. and up per hr.

Electric and Gas Generators Combined for Welding

The Young Sales Co., Inc., of Milwaukee has recently introduced a double-duty gas and electric welding unit which combines the P&H-Hansen 150 ampere portable welder manufactured by the Harnischfeger Corp. of Milwaukee, and gas equipment manufactured and developed by Young Sales Co., Inc. The electric welding unit consists of a P&H-Hansen 150 ampere generator coupled to a Wisconsin air-cooled motor mounted on the standard P&H trailer. Used in connection with this unit is complete gas welding and cutting equipment. This is made up of nationally known make of welding and cutting torches, regulators and associated equipment. A 6-P sight feed acetylene generator is used to furnish acetylene while a special bracket is so arranged as to carry either a large or small tank of oxygen. This combination unit is claimed adaptable for all ordinary work and offers the welder the utmost in economy. Its extreme portability is a feature.

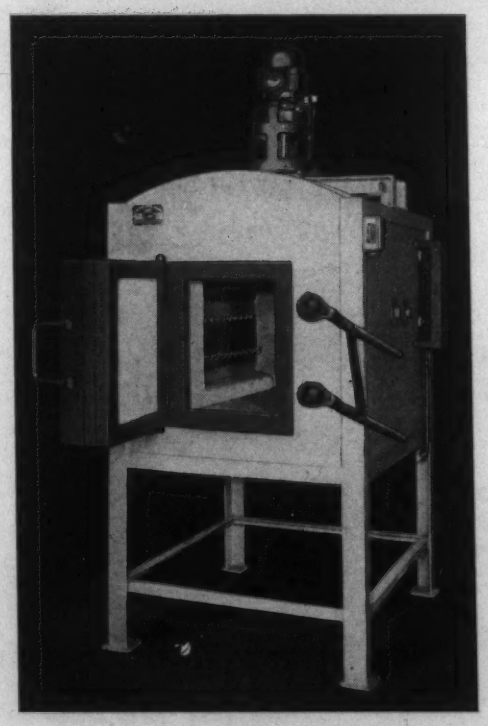
Sweat Pad for Industrial Workers

A new aid to the comfort and efficiency of industrial workers is a sweat pad made from the du Pont company's fine-pore cellulose sponge, and designed to be worn over the forehead. Known as "Drybrow," and manufactured by the American Allsafe Co., Buffalo, N. Y., this pad absorbs 20 times its weight in moisture, due to the cellular construction of the sponge material. Hence, it prevents perspiration from trickling into the eyes and blurring the vision. For those who wear goggles, it saves the need of constantly wiping the lenses while working in hot temperatures, and thus leaves the hands free for the work at hand without interruption.

The device consists of a flat piece of cellulose sponge bound at the ends with tape and equipped with a one-piece latex rubber headband. The sponge is soft and pliable and will not cause irritating pressure. When dipped in cool water and gently squeezed before wearing, the pad stays damp, providing a cool application for the head. This preliminary moistening also lengthens the life of the material.

"AMERICAN" ELECTRIC AIR TEMPERING FURNACES

FOR LABORATORY AND PRODUCTION



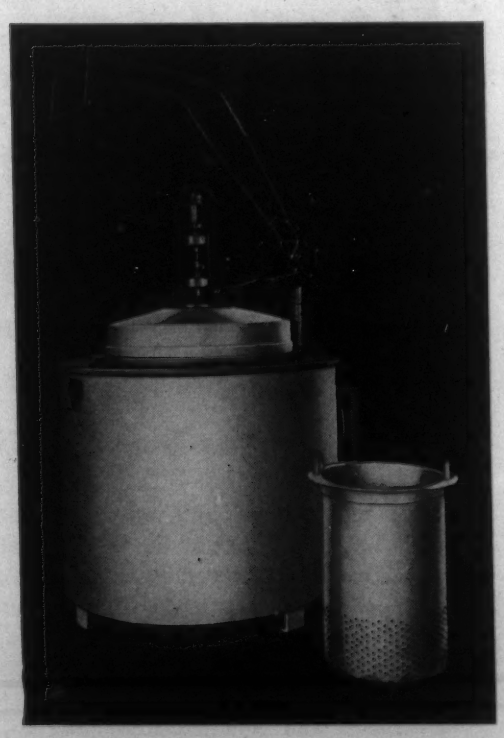
Model AO-1 Furnace
Chamber 12" x 24" x 16"

The ideal unit for individual pieces or production loads up to 1200° F. May be fitted with rack or shelves for holding work.

Positive direct air circulation provides positive temperature uniformity.

Unexcelled for annealing and normalizing all aluminum alloys. Six standard sizes up to 24"x60"x24".

Model NA furnaces illustrated below provide fast uniform tempering of production loads as well as laboratory and experimental work up to 1200° F. Powerful direct air circulation means fast dependable results at low cost. Cleanliness and simplicity of operation reduce labor charges.
Ten standard sizes from 6" diameter x 8" deep to 30" diameter x 48" deep.



Model NA-21 Furnace
Container 16" Diam. x 20" Deep

If you want real results, buy "AMERICAN"

ASK FOR BULLETINS 47 and 30.

American Electric Furnace Company
29 Von Hillern St. Boston, Mass.

All types Industrial Furnaces

B & W "Croloy 7"

The development of "Croloy 7," a new alloy steel for elevated temperature service in tubular form, is announced by The Babcock & Wilcox Tube Co., Beaver Falls, Pa. Croloy 7 is an economically priced steel, intermediate in properties between those of the company's well-known Croloy 5 and Croloy 9. Croloy 7 is already in service in several installations of tubular products and is expected to become an important member of the B&W Croloy Series.

The nominal percentage analysis of Croloy 7 is: Chromium, 7.00; Carbon, 0.15 max.; Molybdenum, 0.45-0.65, and Silicon, 1.00 max. per cent.

Data on high-temperature strength, short-time high-temperature properties, and other characteristics are being rapidly developed and will be available soon.

This new alloy is a result of the metallurgical research program that The Babcock & Wilcox Tube Co. has been conducting for some years past in an effort to develop new alloys for high-temperature and high-pressure service. It was this program which was largely responsible for the development of many of the alloy steels in present day use in tube form. These include notably: 5% chromium steel with molybdenum addition; 2% chromium-0.50% molybdenum steel; 9% chromium-1.25% molybdenum steel; and the further modification of the 2% chromium-0.50% molybdenum type steel by the addition of a higher percentage of molybdenum to obtain increased creep strength and now called "Croloy 2¼."

Amsco Welding Rod

The American Manganese Steel Division of The American Brake Shoe & Foundry Co., Chicago, has a new rod in its line of welding rods, flux, filler bars and dipper tooth repointers. The new product is known as "Amsco Dieweld." As the name implies, it is intended for reconditioning forging dies, hot and cold trimmers, shear knives, punches, cutting tools, etc. It is claimed applicable to all ferrous base metals and deposits with a freedom of porosity by the A.C. or D.C. electric welding method as well as by the oxy-acetylene or atomic hydrogen welding process.

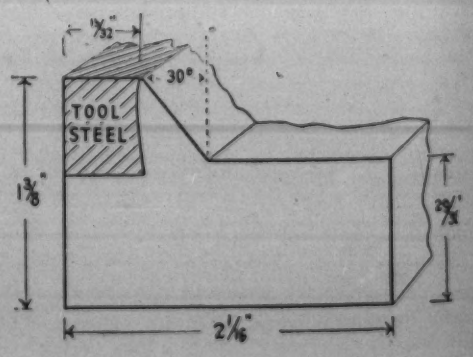
In the test period, some remarkable runs on dies which have been reconditioned with Amsco Dieweld have been recorded, it is reported. On an upset forging operation, in a large forging plant, an average of 18,000 to 20,000 forgings were obtained from an original die installation. After reconditioning with Amsco Dieweld, these same dies produced 29,800 forgings and showed no greater amount of wear than had previously occurred while producing 19,000 forgings.

Amsco Dieweld is air-hardening as welded and must be finished by grinding. For machining, it must be annealed and rehardened after machining. It has an average Rockwell hardness of between 55 and 60, either as welded or heat-treated. Dieweld is available in 3/32, 1/8, 5/32 and 3/16 in. diameters, either bare or coated. Samples and literature are available upon request.

A Die Section

A new die section, designated as Section "D," has just been added to the line of rolled composite die section shapes by the Jessop Steel Co., 546 Green St., Washington, Pa. Section "D" was developed for making smaller dies used in the manufacture of toys, refrigerators, containers, and other articles where composite die sections of smaller size than hitherto available, were needed. Weight per foot of new die section is 7.25 lbs.

Jessop rolled composite die sections, which are now available in 8 shapes, consist of a tool steel cutting edge backed by non-hardenable soft steel. Principal advantage claimed over solid tool steel sections lies in the fact that they may be hardened before drilling dowel holes, thus eliminating expensive lapping operations and assuring a good fit of sections on holder. Because these sections are rolled rather than forged they may be produced in longer lengths, reducing set-up time on machines as well as machining time. Being rolled to shape they are said to save from 28 to 47 per cent, depending on the section, in machining and original purchase weight, as compared to rectangular sections.



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SIL-FOS, the low temperature brazing alloy does just this in joining non-ferrous metals for many purposes. This fact is well demonstrated by its use on electrical equipment.

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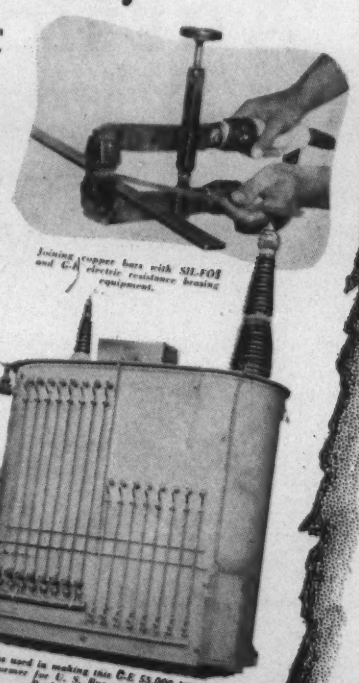
Joining copper bars with SIL-FOS and G-E electric resistance brazing equipment.

SIL-FOS was used in making this G-E 55,000 KVA Power Transformer for U. S. Bureau of Reclamation, Boulder City, Nevada.

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. . . and these joints are important joints in the construction of General Electric transformers. Sil-Fos is used mainly to join taps to coil conductors and for connecting copper bars. It has made 6,000,000 joints . . . every one proved reliable in service . . . and Sil-Fos has done more . . . every joint is high in electrical conductivity . . . and the cost per joint is low. Evidence like this explains why Sil-Fos is now being so widely used. It is solving problems in the manufacture of all kinds of electrical equipment, large and small, and on many other types of work wherever copper, brass or bronze must be reliably joined.

Again we say TRY SIL-FOS on your non-ferrous metal work. Write today for full information about Sil-Fos and Bulletin No. 56MA. We'll be glad to cooperate on specific brazing problems if you'll send us full details.

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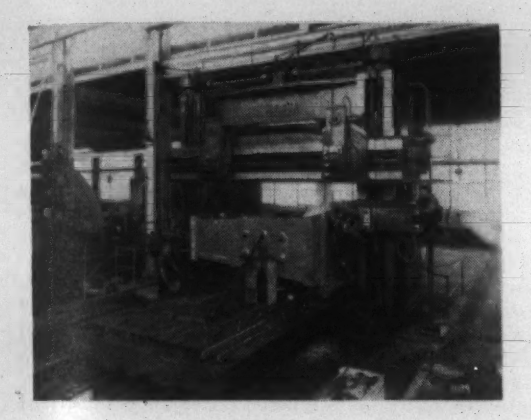
Large Planer for Machining Steam Hammers

To facilitate the machining of the larger parts in building large size steam hammers, the Erie Foundry Co., Erie, Pa., has installed a specially designed planer, probably the largest in the United States. The new planer is of the conventional double-housing type, 16 ft. 6 in. between the housings by 14 ft. 3 in. from the table to the underside of the rail. The table length is 35 ft. 10 in. The total weight of the planer is nearly 900,000 lbs. The table alone weighs 100 tons, and runs on three ways, a V in the middle and a flat at either side. The final table drive is through two racks—one on each side of the middle V.

The drive and speed control are claimed the largest of the type that have ever been built. The main motor drives the table through worm and spur gear reductions. It has a nominal rating of 75 h.p. and under some speed and torque conditions, it will deliver twice this power. The motor is cooled by a separately driven blower. A speed range of 3.2 ft. to



96 ft. per min. is available in both cut and return directions. Individual electric feeds are provided for each head, with feed range per stroke from 1/64 to 1½ in. Pneumatic tool lifters are provided on each head.

In speaking of this new installation, D. Angus Currie, president of the Erie Foundry Co., said, "In recent years, there has been a tremendous increase in the size of parts made by the drop forging process. Of course, a corresponding increase in requirements for very large drop hammers evidenced itself immediately. This new planer has been installed for the machining of parts for the maximum hammer size anticipated for some time to come. It will handle parts for the largest machines which can be transported by present railroad facilities."

Another important result of the installation of this tremendous planer will be its effective use for working out designs heretofore limited by the capacity of available machines in machine shops throughout the country, it is said. More especially can designers appreciate the value of this new planer when they know that hammers are already being built with anvils having a total weight of 500 tons, and individual castings weighing 200 tons can be handled at the Erie Foundry Co. For instance, the Erie Foundry Company is now building one 50,000 lb. rated steam drop hammer (see illustration), three 35,000 lb. rated hammers and two 25,000 lb. rated hammers. Each of these machines has one or more parts which because of its size or weight could not be machined on any planer but this new one.

A Perfected Pump of Glass

Pipes of glass have for many years solved the problem of conveying corrosive liquids and now a perfected pump of glass marks a further step in the safe and economical handling of such liquids. This new pump is of the centrifugal type, in which pumping action is secured from the force of the rotating liquid. Not only the casing, but also the rotating impeller, and all parts in contact with the corrosive liquid are of clear, chemical resistant glass. The rotor is accurately balanced and, running at high speed without appreciable vibration, the pump readily handles 6000 gals. of acid or other liquid and will deliver it 70 ft. above the suction level.

Neither boiling temperatures nor strong acids affect the glass. The problem of pumping hot muriatic acid can thus be solved economically for the first time, it is claimed. So clear is the glass used that the interior of the pump may be watched while it is in operation. Should cleaning be required, the whole interior of the pump can be laid open in a few minutes. All acid solutions (except hydrofluoric or glacial phosphoric acids) may be used without fear of pitting or injuring the hard chemical "Pyrex" brand glass surface.

This new machine was successfully developed by cooperation of the Corning Glass Works, Corning, N. Y., and the Nash Engineering Co., South Norwalk, Conn., which will market the pump.

Soft, Semi-Bright Nickel Electroplates

A new soft, semi-bright nickel alloy electroplate is now being produced commercially by a process of the Hanson-VanWinkle-Munning Co., Matawan, N. J. This process was developed to supply a need which has not been fully met by either the bright nickels heretofore available or by the conventional grey nickel deposits.

Bright nickel deposits as generally known are inclined to be somewhat hard. The new soft coating is nearly as bright as the typical bright nickels; at the same time it flows under pressure on a buff much more easily than either the standard grey nickel or bright nickel. The deposit is extremely ductile, and will stand mechanical forming operations without flaking or peeling, having excellent adherence, even when deposited directly on iron or steel. The salt spray resistance of the deposit is said to be excellent, and it will take chromium plate nicely without extra treatments.

Savings are claimed realized by the reduction in buffing labor and the buffs and compositions consumed in coloring up the deposit. Many instances have also been reported in which fewer polishing operations are necessary before plating, still achieving the same lustre after nickel coloring. The cost of operating the solution is considerably less than that of bright nickel.

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Refractory for Furnace Linings

"Monoplastic" is the name of a new refractory material for lining various types of furnaces. The principal claims made for it are that it does not crack, it does not shrink, it requires no expansion joints, and possesses exceptional insulating qualities. It is manufactured by the Charlotte Chemical Laboratories, Inc., Charlotte, N. Carolina.

This new refractory has been developed so as to make a one piece "monolithic plastic lining" necessitating no expansion joints. It is pointed to as unique in composition, being a carefully compounded blend of several different pure crystalline minerals which have been formed naturally by fusion and are therefore primarily inert to heat expansion and contraction. They undergo no physical changes up to approximately 3,000 deg. F.

Among the physical properties claimed for Monoplastic are the following:

High compression strength.

Tensile strength of 130 lbs. per sq. in. when burnt.

Insulating quality over other plastics.

This new material can be easily applied, like any other plastic, it is said. In estimating the amount for a particular job, the weight is figured at 122 lbs. per cu. ft., allowing a slight margin for waste. When dried and burned, it weighs about 100 lbs. per cu. ft. For repair work it is claimed to be an ideal material.

Some of the other advantages claimed are:

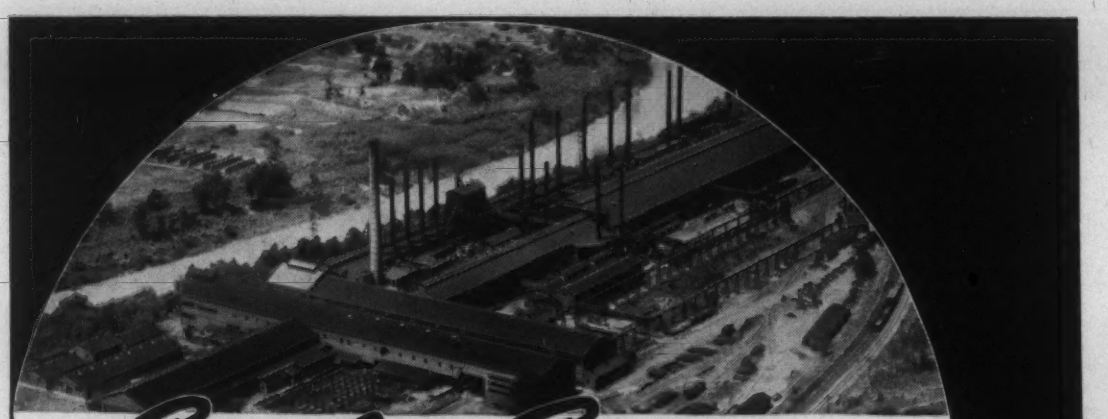
It does not shrink on heating up to approximately 3,000 deg. F. It has no tendency to crack or spall. No expansion joints are necessary.

Can be used in air or water-cooled furnaces.

When furnaced, it resists acids except hydrofluoric. Can be plunged in cold water at a white heat without showing an disintegration.

Not affected by sulphur gases.

Does not accumulate slag and any slag formed does not hold to the plastic as it does to fire brick.



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Illium in Rolled Forms

Of interest to many users of corrosion-resistant alloys will be the news that the Burgess-Parr Co., Freeport, Ill., has succeeded in commercially producing Illium in rolled forms.

For many years Illium, a complex nickel-chromium base alloy of excellent resistance to corrosion by a variety of media, was available only in the as-cast form, as Illium G. The application of its frequently unique corrosion-resistance was thus limited to units of such size and shape that they could be cast directly in the final form desired. This limitation has been removed with the development of Illium R, of essentially the same analysis as the cast product Illium G, but capable of being rolled into strip, rod and even wire. Illium R strip is available in limited widths and lengths and in U. S. S. gages from 8 to 34; the rod is available also in a limited range of sizes; Illium R wire, although not produced in great volume as yet, can be furnished in relatively small lots in any standard wire gage. Illium R strip has been used successfully in the production of welded tubing. Also, Illium R rod to be used as oxyacetylene welding rods or as arc welding electrodes is now available.

Annealed Illium R has a tensile strength of about 100,000 lbs. per sq. in.; elongation (2 in.) 30 to 35 per cent; Brinell hardness 175 to 240; electric resistance, 122.7 microhms per cu. cm. The alloy is non-magnetic. Illium R may be machined, ground, welded, drawn, formed, or polished, if available instructions are followed and other reasonable precautions taken.

Illium R is said to offer the same superlative corrosion resistance to the generally "difficult" corrosive media that won Illium G, in cast form, its reputation for excellence. The additional combination of high strength, formability, machinability and erosion resistance described as characteristic of the new rolled forms of Illium should serve in greatly widening the field of application of this interesting alloy.

Flux for Welding Aluminum

A free flowing flux for gas welding of aluminum and aluminum alloy shapes, has been placed on the market by Park Stewart, 513 Western Ave., Aspinwall, Pa. Known as "Flo-Ez-Flux," it is packed in 15, 5, 2, 1 and ¼-lb. glass containers, such as shown in the illustration. These containers do not corrode, as do metal containers, and they protect their contents at all times from moisture contained in the air, thus assuring an absolutely pure flux which will not cake or harden. The 15-lb. container is equipped with a handle for easy carrying.

Flo-Ez-Flux will stay suspended longer than the ordinary flux, it is claimed, and is finely ground to give a smooth weld, saving the cost of dressing. It may be used to gas weld either wrought, cast or high tensile aluminum or aluminum alloys, of any size or shape where welding is possible. The manufacturer will furnish prices on request.

Cutting Compounds for Taps

For tapping operations, particularly in castings and forgings of aluminum and similar alloys, an excellent cutting compound has been found to consist of "dag" colloidal graphite suspended in mineral oils. The cutting compound is said to provide extremely free cutting action and long tool life, probably due to the "dry" lubricating properties of the colloidal graphite adhering to the surfaces of the threads. Longer tap life is also reported. In addition, the use of the compound enables easier assembly of bolts and studs and prevents freezing of the threaded parts in the tapped holes.

An indication of the lasting lubricating effectiveness of the compound is that, for an average tapping operation, a single drop of the Concentrated "Oil dag" apparently suffices for the tapping of 5 holes as compared to 1 with plain oil. Where tapping equipment is provided with a coolant pump or similar circulating or volume supply system, the Concentrated "Oil dag" may be diluted in the ratio of 15 oz. of colloidal graphite to 2 gals. of mineral oil, according to Acheson Colloids Corp., Port Huron, Mich.

Current Metallurgical Abstracts

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SEPTEMBER, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

2a. Ferrous

Decarburization of Granulated Pig Iron—the "R.K.-Process." (Torrfärskning av granulerat tackjärn, "R.K.-processen") Bo KALLING & IVAR RENNERFELT. *Jernkontorets Ann.*, Vol. 123, No. 3, 1939, pp. 115-154. Practical. The authors have invented the "R.K.-process" for reducing pig iron to a low C content, which may be substituted for steel scrap in steel furnaces. The pig iron is tapped from the furnace and dropped onto a water-cooled revolving drum. The granulated iron thus formed is fed continuously into a rotary furnace and decarburized without melting in a gas mixture of CO and CO_2 in such proportion that no surface oxidation takes place. The reaction gas leaving the charge with some blast furnace gas is burned in air to give the proper CO-CO_2 ratio, and is blown towards the inclined surface of the revolving charge. The consumption of blast furnace gas is very low because of the exothermic character of the reaction. Full-scale runs indicate that there is no difficulty in keeping the average carbon down to 0.10%. HCD (2a)

Incorporating Lime During Sintering Iron Ore (Ueber das Einbinden von Kalk beim Sintern von Eisenerz) J. KLÄRDING. *Arch. Eisenhüttenw.*, Vol. 12, May 1939, pp. 525-528. Practical. Tests with the commercial sintering of Fortuna ore (26.8% Fe, 33.75% SiO_2, 8.62% Al_2O_3, 3% CaO, 2.5% MgO, 9.6% volatile) indicated that from 17 to 36% limestone could be incorporated with the ore without raising the sintering temperature. The incorporated lime had a favorable effect in lowering the viscosity of the blast furnace slag. SE (2a)

2b. Non-Ferrous

New Methods of Light Metal Production (Neue Wege zur Leichtmetallgewinnung) H. GROTHE. *Metall u. Erz*, Vol. 36, No. 3, 1939, pp. 63-72. Review. Brief descriptions of various methods employed to separate Al from its ores include the alkaline process for clays; the Pedersen (Norwegian Aluminum Co.); the Haglund; the acid for high SiO_2 ores, known as the Nuvalon process; and the S. T. process of the Th. Goldschmidt Co. Although these have their field of usefulness, they are no more economical than the standard Bayer process using bauxite as raw material. The use of $AlCl_3$ as the base compound for the electrolytic process demands further attention, as it can be produced more cheaply than Al_2O_3. The electrolytic production of Mg is dealt with briefly, followed by a description of the reduction process of the Austrian-American Magnesite Co. Burnt and ground magnesite is mixed with pulverized anthracite and pressed together using tar as a binder. Reduction is carried out in a 3-phase electric arc furnace at 2200° C. The Mg and CO gases are cooled with H_2 and a Mg dust of about 60-70 Mg, 7 C, 15% MgO, and the remainder, silicides and carbides, is formed. The dust is briquetted without a binder in an atmosphere of H_2. H_2 is recovered in a regenerative apparatus. The Mg briquets are sent to electric ovens where the Mg is distilled in a vacuum of 20-25 mm. and a temperature of 900° C. It is then condensed and dropped into an oil bath to free it of non-metallic impurities from where it is taken out of the vacuum system through an oil trap. The cost is less than that of the electrolytic process, and since no alkalies or halogens are present, the strength properties are superior. The process is adaptable only to magnesite ore. Improvements in the electrolysis of $MgCl_2$ are discussed. 19 references. PCR (2b)

3 Melting, Refining and Casting

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5.

C. H. HERTY, JR.,
and G. L. CRAIG,
SECTION EDITORS

Molding Sands and Binders. Sand testing has become more general in up-to-date foundries, and increased attention is paid to the re-use of old sand. A. J. G. SMITH ("Moulding Sands," *Metal Industry, London*, Vol. 54, May 26, 1939, p. 566) warns against the use of sand of grain size less than 0.06 mm. for any foundry purpose, and points out that 5-15% of available sands are of this fineness. Re-use of old sand may be safely accomplished if dust is removed from it before mixing with new sand and binder. Too coarse-grained sand, however, should also be avoided, and SHEEHAN ("Core-Shop Control," *Foundry Trade J.*, Vol. 60, June 15, 1939, pp. 516-519; June 22, pp. 552-554; June 29, pp. 575, 578) specifically recommends the use of mixtures containing both large- and fine-grained sand. Permeability may be increased by increasing the size of the grains, but this improvement is accompanied by a rougher finish on the castings. A fine sand consisting of rounded grains of uniform size would give satisfactory permeability, with good finish, but the use of fine sand alone increases the amount of binder required, for the smaller the grain size, the larger is the surface area. For economy in binder, as large a proportion as possible of large-grained sand in the mix is desirable. A liberal proportion of fine sand of about 2/5 the unit size avoids the cracking caused by inhibited expansion and also controls the tendency to sag while in the green condition manifested by cores made of sand of uniform, large grain size. The selection of core binders themselves is based on the green strength requirements of the sand mixtures and the dry strength requirements of the finished core. G. H. PIPER ("Bonding Clays and the Properties of Synthetic Moulding Sands," *Foundry Trade J.*, Vol. 60, June 15, 1939, pp. 509-513) has very nicely correlated the strengths of synthetic sands with the nature and properties of bonding clays. The clays examined were china clay, ball clay, fireclay, bentonite, colloidal clay and red clay. Bentonite was found to have the greatest bonding power, and, in fact, the green strength of the molding sand was related directly to the tensile strength of the moist clay. The dry strengths of the synthetic sands are (with the exception of the 3% bentonite mixture) considerably less than those of the natural molding sands.

Green and dry strengths, however, are not the only requirements that sand mixtures must fulfill—permeability, refractoriness and flowability are others. HÜTTENES ("Moderne Kernherstellungsverfahren," *Giessereipraxis*, Vol. 60, Apr. 23, 1939, pp. 166-168; May 5, 1939, pp. 181-183; May 21, 1939, pp. 201-203) discusses several cases of actual mold or casting defects as originating in coremaking, and indicates methods of avoiding them. He stresses the use of high grade core oils, pointing out that "rat tails," casting blowholes and other defects can frequently be traced to the use of poor or hygroscopic core oils. Modern coremaking requires rapid processing, resistance to moisture effects, high permeability, high strength and smooth surface, and low cleaning costs. And almost all of this depends on the choice of sand and binder. X (3)

Eighth Report on the Heterogeneity of Steel Ingots. *Iron Steel Inst. Special Rept.*, No. 25, 1939, 322 pp. As previously, this present volume is a collection of research reports organized within the general field indicated by the title. In the several years during which the Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation has issued these "steel ingot" reports, there has been a gradual shifting of emphasis on specific phases. Thus, the early work was directed at determining the actual degree of heterogeneity and the effect of casting conditions on segregations, inclusions, etc., and considerable improvement in ingot quality resulted. In the later reports attention has been increasingly paid to conditions within the melt as factors in heterogeneity, so that the present report is largely given over to methods of determining gases and gas-metal compounds and to temperature measurement, which must first be standardized and controlled before intelligent study of the melt itself can be made. Andrew, Percival & MacDougall offer confirmation of their previously propounded theory that segregation may occur while the steel is molten; they found considerable S and P segregation in molten steel even when the contents of these elements were about 0.06%. Desch submits evidence that Fe-C alloys with less than 0.10% C solidify entirely in the δ form, whereas those with up to 0.51% C deposit δ crystals that are transformed to γ by a peritectic reaction at 1388° C.; δ cannot be preserved by quenching. Swinden, Stevenson & Speight found that the fractional vacuum fusion method for the separation of gases and oxides in steel gives a total O content equal to that obtained by the direct vacuum fusion method. Comparison of the results for the various fractions with those of residue methods showed (with the exception of the MnO fraction) good agreement; many other data are given to support the validity of the fractional procedure. Two papers testify to the usefulness and simplicity of the carbon-spiral type of vacuum fusion furnace. Gray and Sanders find the Al reduction method (fusing the sample with an excess of Al at 1100° C. in H_2 to transfer the O of the inclusions to Al_2O_3, then filtering and weighing the Al_2O_3) to give results for total O in good agreement with those by vacuum fusion. Colbeck, Craven and Murray, examining the chlorine method for determining nonmetallics in C steels, low-alloy steels and cast iron, find complete breakdown of sulphides, but not of P compounds; Ni, Cu, Mo, V and Ti in low-alloy steels did not interfere, and even Cr gave no trouble, if the chlorination temperature were raised to 500° C.; inclusions in gray cast iron, however, could not be determined satisfactorily by the Cl method. For C and low-alloy steels the Cl method gives results in good agreement with those for total O by vacuum fusion. According to Taylor Austin, the nonmetallics in pig iron and cast iron can be conveniently and satisfactorily determined by a described modification of the aqueous iodine method, but the alcoholic iodine method is completely unsuitable. Other papers describe the application of the alcoholic iodine method to the separation of oxides in steel. The problem of temperature measurement is attacked by Schofield and Grace, who describe a "quick-immersion" thermocouple for measuring liquid steel temperatures in the spout and in the ladle. Precious-metal couples protected with silica tubes are employed; the tubes are spoiled by each test, but the couples can be used repeatedly without re-calibration. The Inclusion Count Sub-committee reported that normal counting methods do not satisfactorily differentiate between large, dangerous inclusions and small, less harmful ones. Reproducibility of results by various observers using both the Fox and the Brown-Firth methods was not very good.

JLG (3a)

The Gas-heated Cupola Furnace (Der gasbeheizte Kupolofen) K. Emmel. *Giesserei*, Vol. 26, Apr. 21, 1939, pp. 193-195. Experiments were made to determine whether theoretical advantages in burning gas instead of the ordinary operation with coke were borne out in practice. In the coke-fired cupola the Fe drips through the white-hot coke charge and is heated to pouring temperature, but in the gas-fired cupola this coke layer is of course absent, and the Fe must be heated in a separate hearth; only the actual melting takes place in the shaft. A furnace construction according to this requirement is described. A charge of 40% foundry iron, 10% hematite and 50% scrap castings was melted and gave a cast iron of 3.34% C, 0.54% Mn, 2.45% Si, 0.60% P and 0.44% S, pouring temperature 1320-1340° C. The castings, of about 5 mm. wall thickness and less, were, when machined, entirely free of pores and blisters. Burning of C is very moderate (2%) and of Si only about half that in coke cupola (about 5%); that of Mn was very high, 23%, of S 24%, while that of P was nil. The experiments showed a good economy of fuel, 20 m.³ gas were burnt per 100 kg. Fe. The author believes his results very encouraging and suggests further more exhaustive investigations.

Ha (3a)

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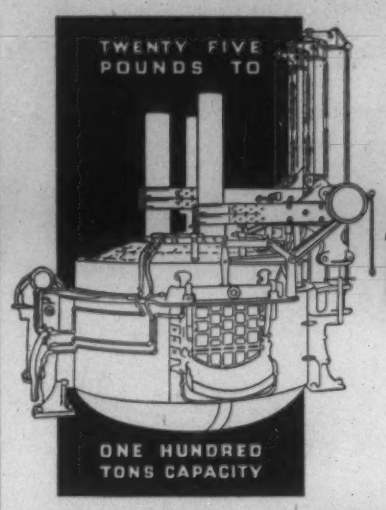

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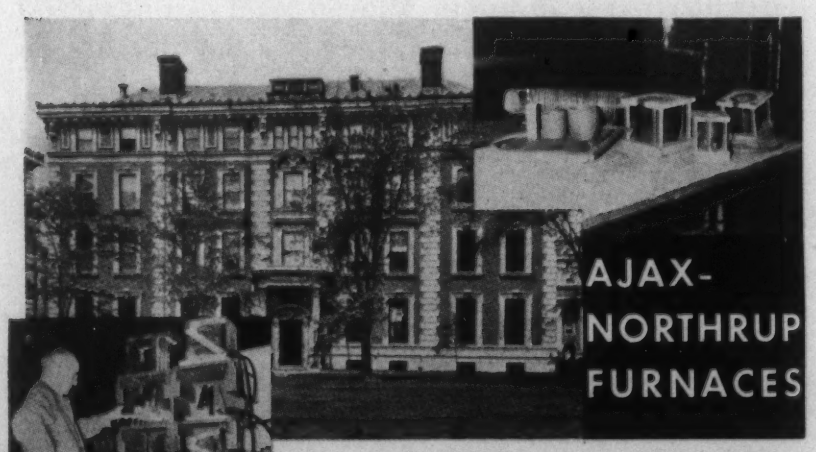

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Porosity and Sinking in Cast Iron. W. West & C. C. Hodgsone. *Foundry Trade J.*, Vol. 60, Apr. 20, 1939, pp. 329-333; Apr. 27, 1939, pp. 344-346; May 4, 1939, pp. 364-365; discussion, May 11, 1939, pp. 389-392. Original research. If it were possible always to keep a well-balanced eutectic mixture for each type of casting commercially produced, less trouble from internal porosity and external sinking in iron castings would be experienced by founders. Originally the sinking effect was thought to be associated with the pig-iron used, or the sand molds and the particular method of making them. The change of raw material that brought about the elimination of the sinking was often misleading. In pursuance of the effect of Ti, experiments were carried out by making additions of ferro-silicon-titanium and treating in a crucible furnace. Pump body castings and shrinkage spheres were used as the test castings. In addition, transverse test-bars 0.875 in. in diameter were also cast. All the castings, except test bars, were cast in green sand. The ferro-silicon-titanium was packed into a steel canister attached to a steel rod protected by a graphite sleeve and immersed in the molten iron. In all experiments, treatment with ferro-silicon-titanium and with CO_2 took place in the crucible. Very little improvement was found when applying the Ti treatment to cast irons which, in their normal condition, possess good mechanical properties, say of the order of 35,000 or more lbs./in.^{2} maximum tensile strength. The most direct method of avoiding external sinking in cast iron is to maintain the total C content over 3.5%. Internal porosity can be dispersed in high total C iron by the treatment with Fe-Si-Ti. The following conclusions were drawn: (1) High-C cast iron composed of pigs from different sources may vary considerably in mechanical properties, although their chemical compositions may be similar. (2) Changes in casting temperature affect the strength of some high C cast irons more than others of similar composition but different structure. Irons that show well-marked pearlite cell walls and fine graphite are influenced less than irons in which the graphite exists as large flakes. (3) Treatment with Fe-Si-Ti effects a marked improvement in the mechanical properties of low-strength high-C cast irons. Additional treatment with CO_2 did not affect the results obtained to any noteworthy extent. CO_2 treatment does not appear to be a method that can be conveniently applied in the foundry. (4) Ti treatment applied in the crucible produces equally good results, irrespective of whether the metal was originally crucible-or-cupola-melted. (5) No marked improvement was found after applying Ti treatment to medium-strength irons. (6) Castings made from irons that solidify with a pearlite cellular structure are denser and less subject to internal porosity (shrinkage) than those made from irons that do show this characteristic. Ti additions greatly assist in the production of this type of structure. (7) The method by which the molds are made (*i.e.* whether hand-rammed or pressed) is not of primary importance in relation to the phenomenon of external sinking. (8) Ti treatment is not effective in preventing pronounced examples of external sinking. (9) Castings made in dried molds are less susceptible to external sinking than those made in green sand. (10) Provided that the molds are dried, the composition of the sand does not seem to be of importance in relation to the sinking phenomenon. AIK (3a)

Cupola Control. H. P. Hughes. *Foundry Trade J.*, Vol. 60, May 18, 1939, pp. 399-402. Most foundrymen have come to realize that a coke bed properly prepared and conditioned is the basis of successful melting, but there are still varying opinions as to how a properly prepared bed should be obtained. The best method is described. The author is in favor of slightly higher bed than is theoretically required, as it gives hotter metal at the start of the cast, resulting in the use of metal which would, as a general rule, be put in the pig bed. A good metal charge is equal in weight to about 1/10 the hourly melting rate of the cupola. There should always be a layer of coke between the charges from 6 to 8 in. in depth; weighing is suitable if there is not a large variation in moisture content. Tangential entry of the blast with tuyeres below the wind belt is said to be superior to right-angle entry with the tuyeres inside the wind belt. The following blast pressure should be suitable for the corresponding diameter of cupola:

Diam.	Pressure (W.G.)
24 in.	12 in.—13 in.
36 in.	15 in.—17 in.
54 in.	19 in.—22 in.

The blast pressure bears some relationship to the tuyeres area, which is itself related to the area of cupola. The figures generally stated for the ratio of tuyere area to cupola area are from 1/4 to 1/9, the ratio increasing as the diameter of cupola increases. The quantity of air required can be found from the quantity of coke used, but there is no direct relationship between the amount of metal melted and the air supply. Knowing the amount of air required to burn 1 lb. of 92%-C coke (generally given as 140 ft.^{3}), one can compare the amount of coke burned per hr. and the quantity of air supplied, with the theoretical requirements. Should

the actual volume of air needed be greatly exceeded, it means that a useless quantity of air is passing through the cupola. Combustion, fuel for combustion, control of pig-iron and scrap, amount of limestone required, etc., are also discussed. AIK (3a)

The "Spiegel Smelting" Process—a New Steelmaking Method (Die Schmelzspiegelreaktion. Ein neuer Weg zur Stahlherstellung) W. ENGEL & N. ENGEL. *Ingeniorvidenskabelige Skrifter B.*, No. 18, 1938, 96 pp.; *Metallwirtschaft*, Vol. 18, June 9, 1939, pp. 479-482. Descriptive of an interesting new method of making steel direct from ore, using carbon as a reducing agent. The six reaction conditions considered feasible for the reduction of the ore were: Reaction of molten ore with solid carbon; reaction of molten ore with carbon monoxide; reaction of molten ore with molten carbon (carbon dissolved in molten iron); reaction of solid ore with solid carbon; reaction of solid ore with carbon monoxide; and reaction of solid ore with molten carbon. Of these, the interaction of solid ore with carbon dissolved in molten iron ($Fe_3O_4 + 4C = 3Fe + 4CO$) seemed most promising. Though the addition of iron ore in the open hearth process is well known, the reaction was studied with the purpose of increasing its efficiency by taking advantage of the high velocity of the reaction. Also, the exothermic nature of the reaction $4CO + 2O_2 = 4CO_2 + 272$ cal. must be exploited, and all circumstances that would hinder the development of a high reaction velocity must be removed. Above all, the reaction products, CO and Fe, must be immediately removed from the reaction zone so that a steady unhindered flow of ore and molten carbon can be applied. These conditions are best fulfilled when the reaction takes place upon a surface, e.g. the surface of the melt. In the first experiments, the authors melted cast Fe (4% C) in a high frequency furnace of 3 kg. capacity and added Fe_3O_4 in the form of scale. After the reaction the bath was recarburized. This procedure was repeated 6 times, until steel was finally obtained. Further laboratory tests were made in which special precautions were taken to prevent the charge from boiling out, the reaction being highly vigorous. Ore was strewn on the clean melting surface at a fixed speed, so that, on one hand, solution of Fe_3O_4 in the bath would be kept at a minimum to avoid boiling, and on the other hand, the reduction of the ore grains would be accelerated so much that the reduction could take place more rapidly than melting or dissolution.

After these tests with charcoal and pure Fe_3O_4 the process was studied using natural ore and coke, simultaneously applying a larger laboratory furnace of 25 kg. content. These tests showed that, on a large production scale, it is not advisable to strew the ore in the middle of the bath surface but to add the ore grains at the periphery, and allow them to migrate towards the center. Experiments on particle size indicate that ore particles 1 mm. in diam. are dissolved in 1 sec. by a melt at 1700° C. containing 5% C. The particles of ore should not cover more than 1/9 of the surface as otherwise they will tend to stick together, thus reducing the dissolving velocity. In order not to reduce the reaction velocity any slag produced must be such as not to interfere with the reduction process. By adding sufficient lime to produce a slag with a very high melting point, containing about 30% SiO_2 10% Al_2O_3 and 60% CaO, all impurities (even S) can be removed. This "dry" slag does not stick to the ore particles or to the coke, does not dissolve the iron oxide and is easily pushed aside by the CO gas evolved by the reduction of an ore particle so as to permit completion of the reaction. As the slag builds up due to siliceous material in the ore it will blanket off the melt and prevent the fine ore and coke particles from reaching the melt. This problem was solved by having an overflow through which both iron and slag poured into a crucible. Other metals can be reduced from their ores by the action of C dissolved in Fe, so that Mn, Cu, Cr, W, Mo and V can be added in this way.

The basis of this process is to remove or decidedly decrease all hindrances so that full advantage may be taken of the reaction velocity of the reduction process. This is so great that the reaction, and therewith the decomposition of the iron oxide, proceeds faster than the melting of the ore. Thus the small particles of ore react dry, without becoming molten, although they are on a surface that is from 200 to 250° C. hotter than the melting temperature of the ore. The actual process of steel making is more rapid and effective, the higher the C content of the metal bath. To process steel by the method outlined it is necessary to apply 2 furnaces. In the first large furnace, pig Fe is produced continuously; in the second furnace pig Fe is refined with ore and as soon as the C content has dropped below 1%, the bath is dephosphorized and desulphurized by CaO. The authors advise the use of the Dreyfus double-frequency furnace, since this furnace permits utilization of the gases of reduction. Calculations on efficiency of the process indicate that it can economically be applied to the direct production of pig Fe and common C steel and that, in particular, it should be suited to the making of alloy steels and Fe alloys, as soon as the process has reached a practical stage. 27 references. GN + GA (3a)

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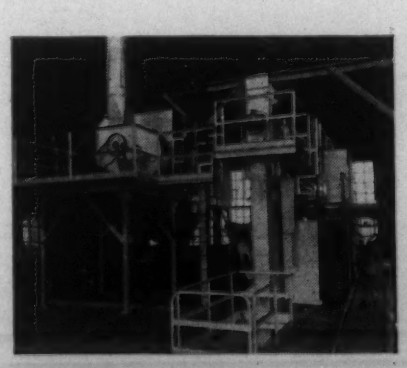

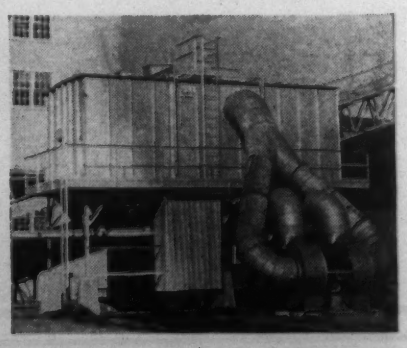

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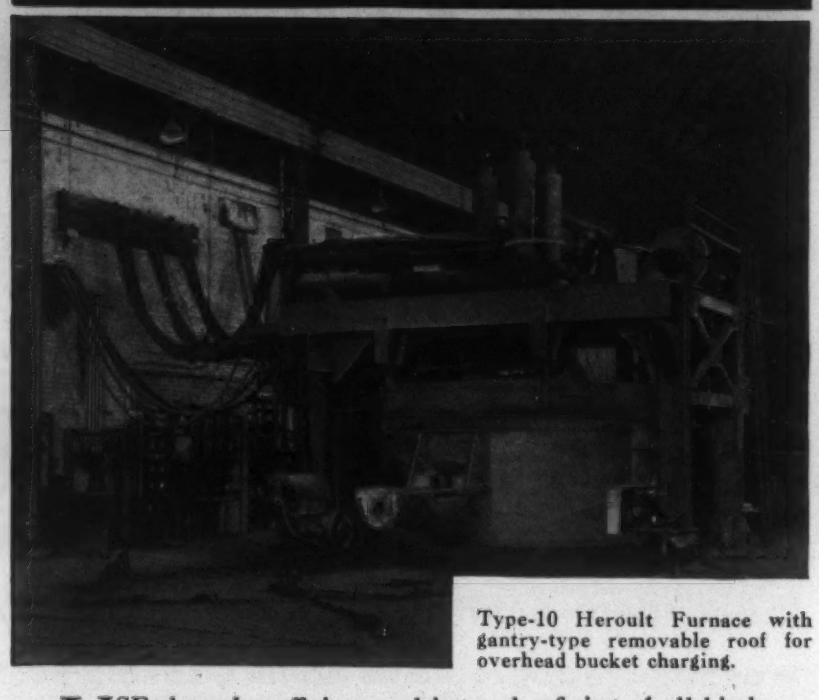

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UNITED STATES STEEL

The Acid Bessemer Process of Steelmaking. The currently reviving interest in, and application of the Bessemer process in Great Britain, where more, and surprisingly higher hourly capacity, converters are swinging into operation, may spread rapidly in this country. At least one American producer ("Jones and Laughlin's Controlled Bessemer," *Metals and Alloys,* Vol. 10, July 1939, p. MA 454) is already giving much attention to improving the uniformity and hence the quality of its Bessemer steel by supplementing operator "eye-control" with a new method, called Bessemer "flame-control," which depends on an ingenious arrangement of photoelectric cells to provide an instantaneous record of the rapid changes in the Bessemer flame. Results are said to be so successful that the company has undertaken additional studies to improve the Bessemer product and believes the general direction of steelmaking procedure may ultimately be considerably affected.

British practice, and what may be interpreted as a representative British opinion of Bessemer steel, are given in a recent series of articles by T. SWINDEN and F. B. CAWLEY ("The Acid Bessemer Process of Steelmaking," *Iron and Steel,* Vol. 12, May 1939, pp. 431-434; June 1939, pp. 593-599.) Many British standard specifications permit use of the acid Bessemer process in an increasingly wider field. As to the gases in Bessemer steel, tests show that O is actually lower than in acid open hearth steel while N is somewhat higher. H, though variable, is present in such small quantities that its effect was not evaluated, but was said to be identical in amount with open hearth steel. The percentages of O and N naturally increase with the time of blow, so that accuracy of blow control is seen to be essential. N increases from 0.002% in the original Fe to 0.015% at the end of blow, usually averaging from 0.011-0.018% in normal Bessemer steel. The N content as determined by vacuum fusion and chemical methods checks exactly indicating its presence only as nitride nitrogen. According to a table comparing various steelmaking processes on the basis of C content necessary for specified tensile values, Bessemer steel consistently meets tensiles with a lower C than any other. The nitrides may account for this behavior.

It is stated that Bessemer steel of similar tensile strength is equal or superior to open hearth steel in wear resistance; machinability, as indicated by large tonnages of screw stock in use is definitely superior. [This position has at least been challenged by the recent development of the leaded open hearth steels.—F.P.P.] Bessemer steels are satisfactory in every way for welding. They are also more reactive to cold work and must be carefully watched in deep drawing operations. Several different tests prove their greater work-hardening ability, and the most pronounced effect is found in lower C ranges. Strain-age-embrittlement is greater in Bessemer than in open hearth steel and this has probably led to apprehension in its use. Data are included showing the superiority of fine-grained steels over coarse-grained in this respect and samples of both types were prepared containing increasing amounts of N. 0.005-0.010% N increases the susceptibility of coarse-grained steels to strain-age-embrittlement but higher percentages do not further increase the susceptibility. In the fine-grained variety 0.005-0.013% does not influence this phenomenon while 0.018% does, but only slightly when compared to the effect on coarse-grained steels. In quench-aging the authors state that C and N contents are the influential factors by their direct effect upon precipitation hardening. In regard to blue-brittleness no apparent difference exists between Bessemer and basic open hearth steel. Possibly because the high N in Bessemer steel may aid in producing surface hardness, such steel has been used extensively as a case-hardening material and in some respects is preferable to other types. HFT (3a)

The Use of the Electric Arc Furnace for the Production of Gray Iron (Die Verwendung des Lichtbogenofens zur Herstellung von Grauguss) G. SPER. *Giesserei,* Vol. 26, May 19, 1939, pp. 237-242. Review. The practical success and spreading use, especially in Germany, of the electric arc furnace for making cast iron is discussed. Three processes can be applied: (1) Combination of blast furnace and electric furnace, whereby the molten iron is transferred directly to the electric furnace and there refined. (2) Combination of cupola and electric furnace, whereby the charge is melted in the cupola and the molten material treated further in the electric furnace; this method, commonly known as "duplexing," is the most widely used. (3) A charge of steel and cast iron scrap is melted directly in the electric arc furnace; this is called the "synthetic" process, as C, Si and Mn are added as ferroalloys to obtain a definite composition. The efficiency of the electric furnace depends largely on the quality of the electrodes; the graphite electrode is preferable to the amorphous carbon electrode in spite of the higher cost of the former; graphite electrodes are always used for furnace units of more than 6 tons. Desulphurization requires a strongly basic slag, CaO + fluorspar + coke powder. The following reactions take place in the sequence as given: $FeO + Mn = MnO + Fe$; $MnO + C = Mn + CO$; $CaO + 3C = CaC_2 + CO$; $MnS + CaO + C = Mn + CaS + CO$; $FeS + CaO + C = Fe + CaS + CO$. CaS is insoluble in Fe. The average composition of a good electric furnace slag is 16-20% SiO_2, 0.8-1.3% FeO, up to 3% Al_2O_3, 0.3-0.4% MnO, 55-64% CaO, 3-8% MgO, 10-15% CaC_2, 3-4% S. High quality cast iron should have low C, S and P content, pearlitic structure and fine distribution of graphite; P, however, should not be lower than 0.3% as this content gives optimum mechanical properties. The fracture of electric cast iron is very fine-grained, uniform and dense, even in large sections. The electric furnace offers an ideal refining medium, especially for Ca-Si treatment, which is widely used in the production of "high-test" iron. The factors for most economical operation, such as cost of electrical energy and continuity of melting, are discussed. Ha (3a)

The Duplex Process: Basic Bessemer-Electric Arc Furnace (Beitrag zum Duplexverfahren: Thomasbirne-Lichtbogenofen) R. GRAEF. *Stahl u. Eisen,* Vol. 59, Mar. 30, 1939, pp. 385-395. Practical. The metallurgy of the recently-used duplex process (basic Bessemer-electric arc furnace) was studied. The blown metal is carburized with coke as the converter is tapped. Desulphurization of hard steel to max. 0.020% S takes 55-65 min.; with soft steel, the time is somewhat longer. About 70-110 kw.-hr./ton is used in desulphurizing. During this interval there is sufficient time to obtain the desired deoxidation. No harmful effect of N was noticed. The consumption of graphite electrodes was 1.5-3.0 kg./ton of steel. Higher voltages gave less graphite consumption. Pressed dolomite bricks proved serviceable for the electric furnace lining, the hearth lasting over 2500 melts with the duplex process. Cooling at the door openings materially increased the life. SE (3a)

Pipe Elimination in Steel Ingots. E. ALTENHEIM. *Iron & Steel,* Vol. 12, Jan. 1939, pp. 250, 260. Practical. Deals with general features of solidification of steel ingots, and shows advantages of using a properly selected insulating material for covering metal in open type molds. Photographs included show results of using different methods. Use of the patented "Lapix" insulating material has proved best by test, as it reduced the discard of ingots due to piping by 4-6%. Material is light, to prevent its being carried downward into rimming metal, and is free from any recarburizing constituent. The use of aftercast method is possible with Lapix, further reducing pipe discard. The compound is said to prevent V-shaped pipes and promotes well defined, localized, and uniform shrinkage in the top of ingots. HFT (3a)

Some Experiences with Basic Bessemer Steel. JAMES MITCHELL. *Proc. Staffordshire Iron Steel Inst.*, Vol. 53, 1937-38, pp. 85-94; discussion, pp. 94-100. Practical comparative description of English basic Bessemer vs. basic open hearth process. Based on the representative analyses the basic Bessemer steel is supposed to contain similar amount of O_2 for the same C content as the basic open hearth steel. In making fully-killed steel containing less than 0.1% C in the open-hearth, with a limit of 0.03% Si (max.) it is found that, in addition to Fe-Mn and Fe-Si, about 12 oz. of Al per ton or 0.033%, are required. For comparison some tests were made on the production of a similar steel by the basic Bessemer process, but without any Fe-Si addition. About 16 oz. per ton of Al, or 0.045%, are found to be more than adequate to completely kill the steel. (These results were questioned during the discussion.) The analyses of seven open-hearth steels taken at random shows the following variation in incidental alloying elements:

	Lowest Percent	Highest Percent
Arsenic	0.033	0.059
Nickel	0.047	0.154
Chromium	0.033	0.068
Copper	0.005	0.155
Tin	0.008	0.088

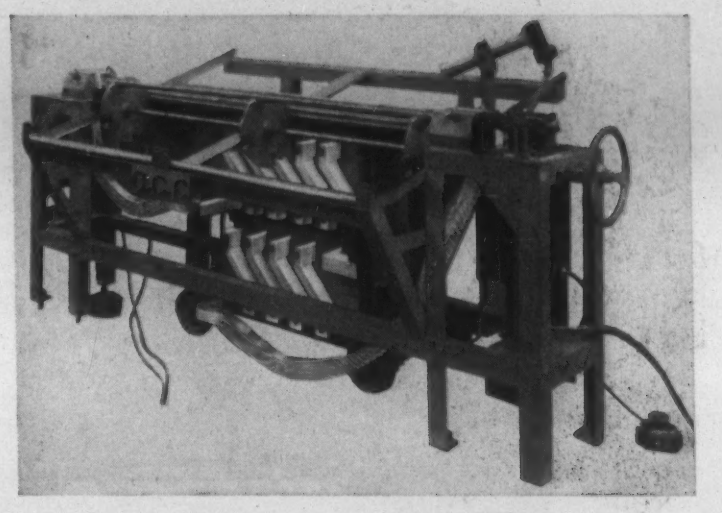
On a particular rolling mill practice, the substitution of basic Bessemer steel for open-hearth steel, showed, on mill records over a considerable period, improved output of about 17% when every allowance is made for other variables in the comparison. In general, a much higher degree of cold malleability may be obtained easily on basic Bessemer than on basic open-hearth steel. Many tests have demonstrated that basic Bessemer steel can be deformed to a much greater extent than similar open-hearth quality. A further useful characteristic is displayed by a series of tests on quench aging. Two rimming steels of similar composition, one basic Bessemer and one open-hearth, were examined. After cooling from 1050 deg. C., they were water-quenched from various temperatures below A_1 and allowed to age until a constant hardness was attained. The curves show that in the case of basic Bessemer steel, there was a more rapid increase of hardness and that the ultimate hardness obtained was considerably greater than that of the open-hearth steel. In discussion, the open-hearth men critically discussed some of the claims mentioned above. GTM (3a)

3b. Non-Ferrous

Pressure Die-Casting in Aluminum- and Zinc-Base Alloys. ARTHUR STREET. *Foundry Trade J.* Vol. 60, June 15, 1939, pp. 535-541. Review. The conditions under which die-casting are made are so severe that only certain alloys are suitable for the process. Over 80% of the pressure-cast tonnage in England is made up of (1) The zinc-base alloys (4% Al, 0 to 2.7% Cu, 0.03% Mg, remainder Zn of 99.99 plus % purity); (2) aluminum alloy with 11 to 13% Si, and occasionally Cu up to 0.5%; (3) a small amount of Al alloy with 4-5% Cu and 2 to 3% Si; (4) miscellaneous alloys. The list of alloys not considered to be commercially "pressure die-castable" include many that could possibly be adapted to the process if the need were urgent. Thus gunmetal and pure 70-30 brass could be pressure-cast if the mold and the die-casting machine were specially designed for the purpose. The improvements are being developed in the die-casting of high melting-point alloys such as cast iron and Ni alloys. The life of the die is not a direct inverse function of the melting point, but an exaggerated one; thus the life of a part of a tool for Zn alloy die-castings would be at least 4 times that of a part of the die producing an Al-alloy pressure die-casting. The effect of freezing range of the alloy may be an important factor, for a long freezing range indicates that the alloy may be difficult to pressure-cast without unsoundness. The popular pressure die-casting alloys are those with the shortest freezing range. Aluminum bronze is an exception; in this case other factors interfere and make the alloy difficult to pressure-cast. The reason alloys with long freezing range are generally difficult to pressure-cast is that the first solidified metal bridges across the section encircling the portion of still solidifying alloy, which is thus prevented from being fed. AIK (3b)

Method and Device for Processing Compound Castings (Verfahren und Vorrichtung zum Herstellen von Verbundgussstücken) FENNEL. *Giessereipraxis*, Vol. 60, Mar. 12, 1939, pp. 112-114. Descriptive. A new method of eliminating segregation in the lining metal of antifriction bearings and of obtaining close contact between bearing metal and steel chill is described. The bearing chill equipped with a tube-like hollow core is preheated to 500° C. and inserted in a graphite crucible filled with liquid borax at 1200 deg. C. The work piece is thus heated to 1200 deg. and the lining metal then cast-in, while the borax is displaced. The crucible and its contents are then cooled in water while a water spray simultaneously cools the hollow core. After destruction of the crucible the bearing or any other type of compound casting can be readily processed. GN (3b)

a.c.f. BERWICK



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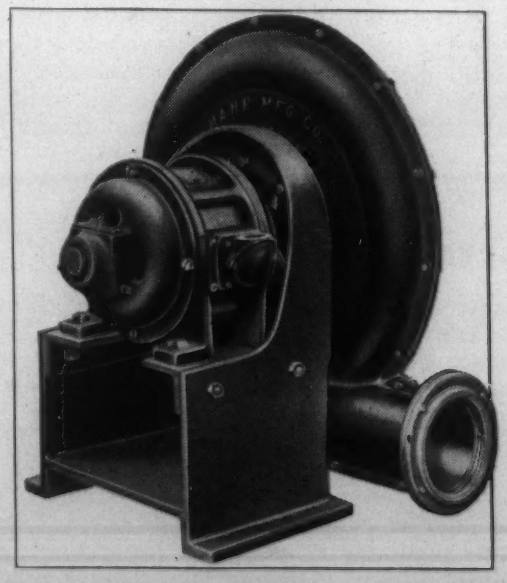

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4 Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER

AND H. W. GRAHAM,

SECTION EDITORS

Theoretical Considerations Involved in Reactive Wire Drawing. H. A. STRINGFELLOW. *Wire & Wire Prod.,* Vol. 14, May 1939, pp. 253-257. A further theoretical investigation of wire drawing with back-pull, called reactive drawing, explains the process. Briefly, the shearing stresses developed due to the die pressure alone are not of sufficient magnitude to reach the effective stress of deformation. The shearing stresses induced by the back tension, however, act on planes at 45° to the axis of the wire, which are the planes of maximum free shear. In the die cone, these planes must rotate to accommodate the cone angle, as this determines the angle of principal shear in the die. In the same section, maximum shear cannot exist simultaneously on 2 different planes. Neither of the 2 shearing stresses is alone sufficient to effect reduction; the latter must be effected by the combination of the 2 stresses, as no other forces are acting. Because maximum shear cannot exist simultaneously on 2 different planes, the planes must rotate so that it can be reasonably assumed that the crystal grains that form their boundaries must rotate also. Attention is drawn to another benefit of reactive drawing, as the wire goes into the die better-centered and drawing failures caused by eccentric wire location are avoided. See also *Metals and Alloys,* Vol. 10, June 1930, p. MA 339L5. Ha (D-4)

4a. Ferrous

Steel Quality as Related to Hot Working Properties. H. ALEXANDER DICKIE. *Iron Age,* Vol. 143, Apr. 27, 1939, pp. 42-45. Review. Performance of steel during hot working and merit of resulting product depend on the fundamental quality of steel and on conditions imposed on steel during heating and working. The composition must be related to the properties required in the final product as well as method of production. C in C-steel has a greater effect than other common elements on malleability at high temperatures. As C decreases, C-steel becomes softer and more malleable at any given temperature; at the same time it is possible to heat to higher temperatures and take advantage of increase of malleability with temperature. Basic Bessemer steel will roll to a thinner section on a particular roll setting, because of its low content of elements that interfere with free flow of Fe base, such as C, Si and minor impurities, such as Cu, Ni, Sn. In ingot Fe, in a temperature range that extends for about 360° or 540° F. above the highest critical point, there is a hot shortness, which in ordinary steels is affected by Mn, S and O contents. Steels worked immediately after solidification need higher Mn-S ratio to ensure freedom from hot shortness. Type of steel and uniformity are of great importance. Rimming steels give superior surface, owing to purity and self-welding properties. Hot worked steel, particularly steel with low or medium C, may easily have 50% or even 100% higher impact value in a hot worked condition, as incorrect normalizing may reduce impact value to only 5% or less. Cu causes red shortness when present above about 2%, but in actual fact, steel with 0.20% Cu may give serious trouble at ingot stage and during hot rolling. Trouble is caused in disintegration of the steel, either at the surface or more deep-seated. This may be avoided by addition of Ni to about ½ of the Cu content. The basic cause of such disintegration is S or S-compounds in the furnace atmosphere. VSP (D-4a)

Cold-forming Operations on Stainless Steels. W. M. MITCHELL. *Am. Machinist,* Vol. 83, May 3, 1939, pp. 290-292; May 17, 1939, pp. 341-343. Practical. The correct handling of stainless steels for press work, spinning and draw-rolling is discussed, and suitable tools described. The dies should be made of alloy steels, (high C and high Cr), or cast iron preferably 3.0-4.0% C, 0.6-0.9% Mn, 1.0-1.5% Si, 0.6-1.0% Cr, 2.5-3.0% Ni. Heat treatment for the latter should consist in heating to 1550°-1600° F., holding for 1 hr. for each 1 in. of section and quenching in oil, then drawing at 700°-900° F. to give a Brinell hardness of 280-340. Lubricants in drawing and spinning are preferably lithopone and linseed oil in equal parts by volume, thinned with kerosene; or white lead thinned with linseed oil, or castor oil and emulsified soap, or powdered graphite mixed with water to a thin paste. Procedure during and subsequent treatments after the forming processes are described. Ha (D-4a)

4b. Non-Ferrous

Non-ferrous Rolling Mill Practice. The recent installation in this country of a non-ferrous rolling mill that rivals in size and mechanization the sort of thing we have come to expect of modern steel plants exclusively, calls attention to developments in non-ferrous rolling generally. W. F. CHUBB ("Non-ferrous Rolling Practice," *Metal Ind., London,* Vol. 54, June 9, 1939, pp. 603-608) in reviewing them, points out that recent modifications have had the general effects of reducing roll deflection, decreasing power consumption, increasing speed and output, and improving uniformity. Attention to lubrication has become more careful. Where the metal is maintained under tension, the chief influence of a lubricant is revealed in its effect on stretching, increased stretching being noted when a high-fatty-acid lubricant is employed. For most work straight lubricating oils are preferred. In Al, Cu, Ni and constantan, the rolling texture is related to the superposition of two crystal strata, whereas in Ag, brass and bronze it is associated with only one of these strata.

Rolling practice for Al, its alloys and clad products is described by A. T. COOTE ("Non-Ferrous Rolling Mill Practice," *Metal Ind., London,* Vol. 54, May 26, 1939, pp. 555-560). The need of steady continuous pouring is stressed, and the importance of cooling ingots and preparing billets for rolling, so as to avoid both inverse segregation and columnar crystals perpendicular to the rolling direction, is emphasized. The system of producing rolling billets by extrusion is said to be better than that of casting the billets to rolling size without intermediate working. For sheet the ingot is broken down to about 3/16 in. by hot rolling and annealed at 350° C. The annealed slabs pass to the roughing mill and are broken down to 0.080 in. and returned for annealing. They are then reduced by 25% steps between anneals in the finishing mill. Various rolling oils may be used, including light spindle oil, kerosene, sperm oil and soluble oil. For the gray plate finish, fish oil is used. With the claim that roller bearings use less power the author agrees, but he believes, with respect to gage uniformity, that equally good results are obtained with the modern type of pressure or flood-lubricated sleeve bearing. Using soluble oil lubrication, bakelite bearings in heavily-loaded hot breakdown mills (2 tons/in.^{2}) stand up exceptionally well. Care should be taken to keep a good finish on the rolls. Methods of roll inspection and upkeep are discussed and a mill layout is outlined. RWB (E-4b)

The Mechanical Properties of Cold-worked Material as Affected by the Amount of Rolling, Grain Size, and Direction in the Sample (Die mechanischen Eigenschaften kaltgewordener Werkstoffe in Abhängigkeit von Walzgrad, Korngrösse und Probenrichtung) H. UNCKEL. *Z. Metallkunde,* Vol. 31, Apr. 1939, pp. 104-108. Experimental. Data on the yield point, tensile strength, hardness, elongation, reduction in area, and bending strength were obtained for sheet rolled from large- and small-grained ingots of Al, Cu, 72%-Cu brass, and 95%-Cu bronze. The values for yield point and tensile strength, averaged over all directions, are higher for the fine-grained material although the values in the rolling direction were the same for large- and small-grained samples at high degrees of deformation. Elongation was the same for both types, but the reduction in area was greater for large-grained material. The yield point and tensile strength increases while the elongation decreases away from the rolling direction. These effects can be explained by the influence of slip systems in building up preferred orientations. GD (E-4b)

5 Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering, Furnaces, Soaking Pits, Refractories, Asmospheres, Fuels and Auxiliaries.

O. E. HARDER and H. DREVER
SECTION EDITORS

Insulating Firebrick. W. RAYMOND KERR (Armstrong Cork Co.) *Steel,* Vol. 104, Apr. 3, 1939, pp. 42, 45-46. Descriptive review. Chemical composition is unimportant in most cases provided other properties of the brick enable it to withstand working conditions. For strongly reducing conditions, low Fe content, *e.g.* about 2%, should be specified. Pyrometric cone equivalent usually is no indication of useful range. The temperature at which brick is originally fired determines the temperature at which it can be used. Bulk density is important for several reasons and should be included in all specifications. If insulating fire-brick is to back up a refractory, the density should be relatively low—about 30-35 lbs./ft.^{3} For light duty service in average industrial furnaces, it can be 35-50 lbs./ft.^{3} For relatively severe conditions, it may range up to 65 lbs./ft.^{3} Accuracy of dimensions is important. Tolerance of $\pm$ 1/32 in. is reasonable. Where bulk density is specified, it is unnecessary to mention porosity, as the latter varies almost directly with the former. Permeability is hard to control and should be included in specifications only when it can not be compensated for or minimized by use of tight steel-shell construction, or where its reduction by coating inside of furnace lining may not be practical. Compressive strength is not so important in modern constructions except where unusual thrusts occur. It is, however, a good measure of how well the brick will withstand shipment, and should not be less than 150-175 lbs./in.^{2} Transverse strength is of little importance except where a single span or a wall tie-in is concerned. Thermal conductivity is a most important factor and should be included in all specifications. Maximum should be 2-4 B.t.u. at 1500° F. mean temp. depending upon the application. No hot-load test is sufficiently well developed at present to be included in general specifications except, perhaps, in special cases. Spalling resistance is extremely important, but there is no standard test for its determination at present. Panel-type test may offer best solution. Freedom from shrinkage and effect of time on shrinkage are important. Short-period test should not be used. If A.S.T.M. soaking test is used, allowable linear shrinkage at any given temp. may be 2-2.5%. For panel type test, it should be as low as ½%. Certain atmospheres induce more shrinkage than normal oxidizing conditions, so that it may be desirable to design shrinkage tests under special atmospheres. MS (5)

Hot Patching of Refractories by Blow-pipe Spray Welding. C. H. S. TUPHOLME. *Ind. Eng. Chem., News Ed.,* Vol. 17, June 20, 1939, pp. 426-427. Practical. Furnace and oven refractory settings usually have to be reconstructed long before the greater part of the refractory has worn out, involving considerable wastage of labor and materials. At present, attempted routine repairs are carried out in many plants by spraying and gunning with slurries and pastes of refractory cement and water, but adhesion of the cement is poor. Hot repair methods offer the possibility of effecting savings in refractory costs without the practical disadvantage of poor adherence. A special oxy-gas burner, the design of which is described in detail and illustrated, produces a small and intensely hot flame, capable of fusing the refractory material fed to the point of repair at a rate of 1½ to 2 oz. per min. The composition of a very good fusible cement is 90% SiO_2, 5.7 Al_2O_3, 0.4 Fe_2O_3, 0.3 TiO_2, 0.5 CaO, 0.15 MgO, 0.25 Na_2OK_2O, 2.8 loss on ignition. The fine-cement feed device is interposed in the oxygen line to the burner. In passing through the device the oxygen picks up cement powder and carries it to the burner head, whence it flows through the flame and is impinged upon the oven wall at the position of the leak and builds up in a semimolten condition. It has been possible to patch a hole, 1-2 in. in area, to a depth of 1 in. in 10-15 min., 2 men handling the job. The details of the hot repair technique are described minutely. The method is now being studied by steel operators in Britain, who foresee considerable economies in oven operation. MEH (5)

Qunching Oils. Quenching oils, always a bone of contention but seldom submitted to systematic study, are the subject of 3 papers in the recently published Second Report of the Alloy Steels Research Committee, issued as *Iron & Steel Inst. Special Report* No. 24, 1939. J. A. JONES & W. W. STEVENSON ("The Properties of Quenching Oils," pp. 269-282) tested 7 different commercial quenching oils to determine what relation existed between their nature and general merit. They conclude simply that no hard and fast rule can be applied to decide the relative merits and demerits of quenching media. Each branch of quenching should be considered separately and the appropriate oil chosen from the results of volatility, viscosity, oxidation and other tests applied to determine the expected behavior of the oil in the shop. G. STANFIELD ("Quenching Tests in Various Media," pp. 299-318) arrived at somewhat the same conclusion after determining the rate of fall of temperature at certain positions within a cylindrical mass quenched in various oils; in some of the tests attempts were made to follow actual changes in surface temperature. Different types of oil were found to vary substantially in their quenching properties, the quenching effect being largely influenced by the type of surface. A scaled surface tends toward a more rapid quench. No definite connection could be established between quenching properties of an oil and its physical and chemical characteristics. The importance of the scaled surface was independently verified by RUSSELL ("Some Tests on Quenching Oils," pp. 283-298). Tests on a small cylinder of low Ni-Cr steel and on a sphere of austenitic Ni-Cr steel, with the thermocouple at the center in both cases, showed that appreciable differences were obtained on repeat tests. These differences were found to be due to differences in the nature of the scaled surface. JLG (5)

Refractory Bricks, Their Manufacture, Their Properties in General and Their Applicability in the Metal Industries in Particular. J. KRATZERT. *Elektrowärme,* Vol. 9, June 1939, pp. 117-127. Review. All commercial refractories are mixtures of some kind, never definite single substances. The silica group consists of at least 95% SiO_2, with lime used as binder. Pure clay ($2H_2O.Al_2O_3.2SiO_2$) transforms at 500° C. to a waterfree compound and disintegrates at higher temperatures into SiO_2 and Al_2O_3, but at still higher temperatures a new stable molecule, mullite, is formed. Cyanite and sillimanite are raw materials of $Al_2O_3.SiO_2$; cyanite disintegrates at 1300° C., also forming mullite. Magnesite and chromite are composed of 85-92% MgO or 30-50% Cr_2O_3 with SiO_2, Al_2O_3, FeO, Fe_2O_3 and CaO in varying proportions. Behavior in service, structure and mechanical properties are discussed at length, and the reactions taking place in service and leading to destruction described. Bricks are destroyed not only by liquid slag but also by gases. Fe-containing bricks are strongly affected by CO at 400°-500° C., when the gas disintegrates under the catalytic action of Fe_2O_3 and C is deposited in the interior of the brick, leading to its destruction. Alternate reducing and oxidizing atmospheres have a harmful effect on Cr-containing materials above 1000° C. and the bricks become brittle and fall apart. SiC-containing materials are destroyed in oxidizing atmospheres above 1300° C. Gaseous alkalis reduce the refractoriness. The resistance to temperature fluctuations is increased considerably by keeping the elasticity modulus low as in fireclay and magnesite. Ha (5)

Refractories in Non-ferrous Metallurgical Furnaces. J. SPOTTS MCDOWELL (Harbison-Walker Refractories Co.) *Mining Congr. J.,* Vol. 25, May 1939, pp. 17-20. Review. Among newer products used as super-duty fireclay brick, refractory insulating brick, chemically bonded magnesite and chrome brick, low-Fe magnesite brick, and forsterite brick. De-aired extruded fireclay brick is giving good service in Zn distillation furnaces and should find economic use in Pb furnaces. Vacuum pressed fireclay brick is used in Ni reverberatory furnaces. Alumina brick is used in Ni furnaces and coal fired Cu reverberatory furnaces. Power pressed silica brick is also used in Ni and Cu furnaces. Forsterite refractories that show only slight shrinkage at temperatures high enough to melt silica brick are also finding application in Ni and Cu reverberatory furnaces. The present trend toward basic refractories in roofs may be expected to continue. Economies resulting from insulation have been demonstrated satisfactorily in many furnaces. BHS (5)

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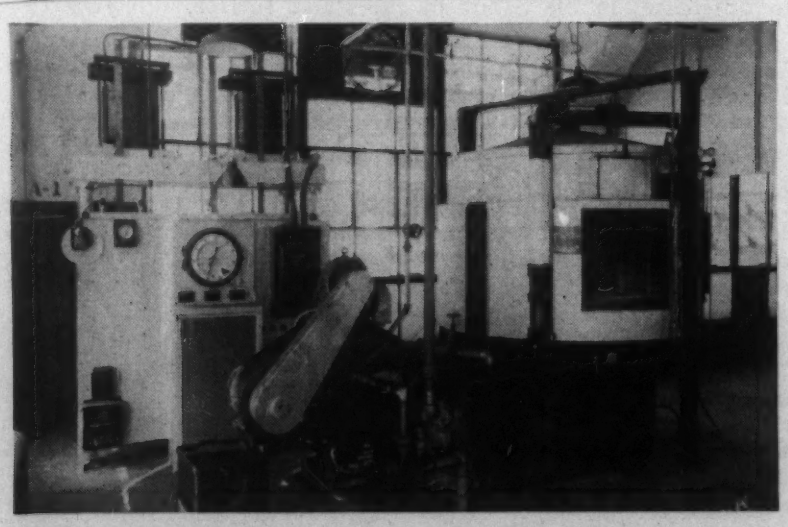

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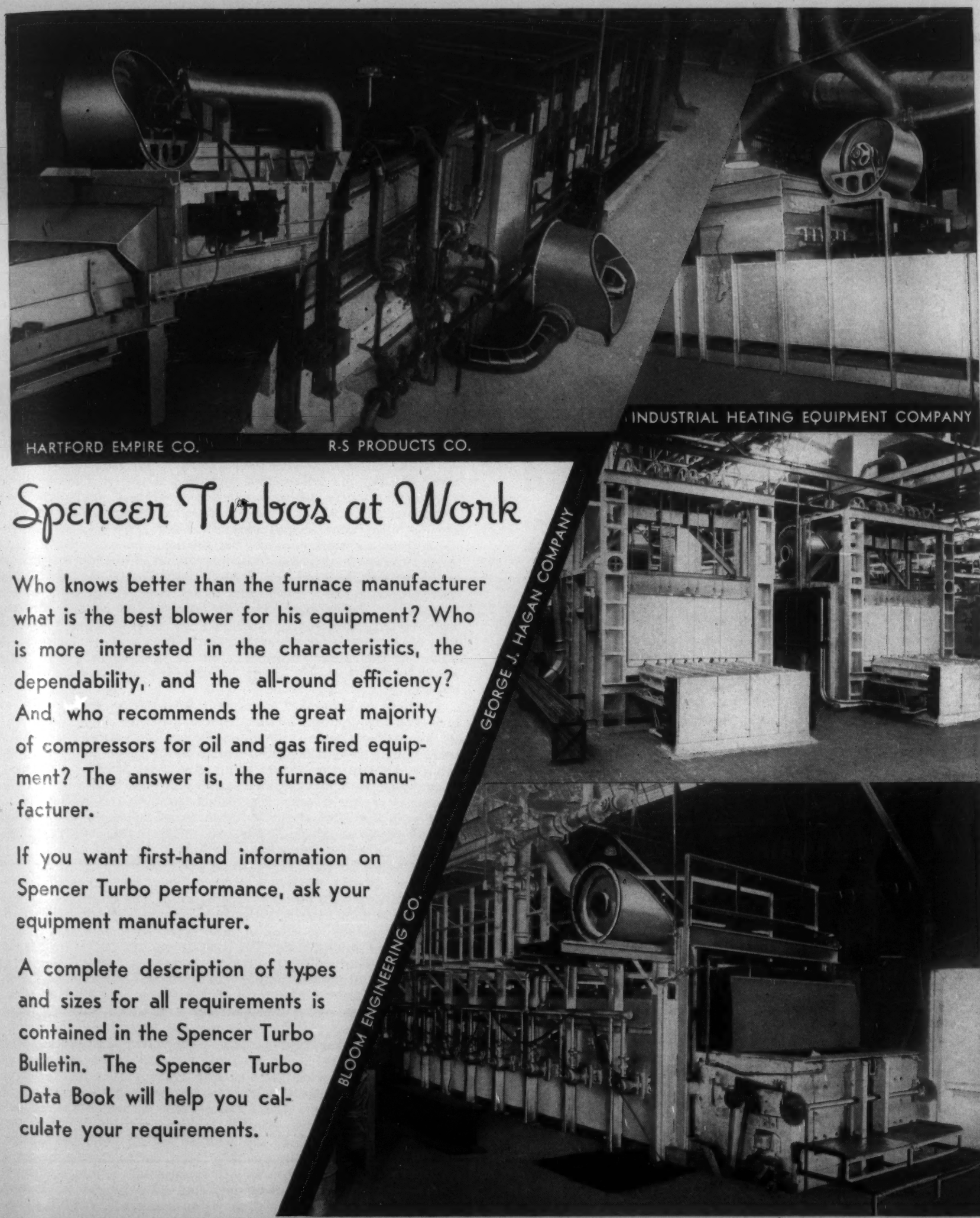
5a. Ferrous

1 **Factors Influencing the Rate of Spheroidization and Graphitization in Carbon Steels.** C. L. SHAPIRO. *Ind. Heating*, Vol. 6, May 1939, pp. 402-406. Original investigation into the factors that influence the rate of spheroidization in various heat-treated steels. When annealed pearlitic steels are heated below their thermal critical range (650° C.) pearlite forms spheroidized cementite very slowly, either by agglomeration of the Fe carbide
2 particles at the grain boundaries, by gradual decomposition of the cementite lamellae, by spheroidization commencing at the extremes of each individual cementite lamella, by agglomeration occurring at the intersection of cementite lamellae, by absorption of one cementite lamella by another, or by the formation of nuclei either within the cementite lamella or in the ferrite between the lamellae; several of these factors can work together. Cold-working has an effect on the rate of spheroidization inasmuch as cold work prior to spheroidizing accelerates the speed of spheroidiza-
3 tion. Normalizing from above the thermal critical range produces a finer state of pearlite division in C steels and, therefore, a quicker rate of spheroidization than in furnace-cooled pearlitic steels. When hardened steels are tempered the carbide particles possess their maximum agglomeration velocity and coagulate very quickly to form spheroids of cementite, the ultimate size of which is a function of time and temperature; the optimum temperature to obtain the largest cementite spheroids is immediately below the critical range; the higher the C content and the finer the state of
4 carbide dispersion the shorter the tempering time required to obtain maximum spheroidization. Higher quenching temperatures and slower cooling mediums (oil) decrease the rate of agglomeration, very likely because of an increased amount of retained austenite. Cold-worked eutectoid (0.87% C) or hypereutectoid (1.2% C) steels graphitized more readily than unworked steels of the same heat-treated condition when heated below the critical range for the same length of time; the amount of cold work and time at 650° C. determines the degree of graphitization. Steels
5 quenched from above the thermal critical range also have a tendency to graphitize, but only when subjected to tempering of long duration. Annealed eutectoid (pearlitic) steels seldom graphitize unless cold-worked or held for an extremely long time at 650° C. Material in the spheroidized structural condition (quenched-and-tempered) is more susceptible to graphitization than annealed (pearlitic) material. The response of various steels to graphitization is appreciably affected by certain alloying elements; Si, Cu, Al and Co accelerate the formation of graphite, while the carbide-
6 forming metals, such as Cr, W and V, retard graphitization. Any factor tending to reduce the stability of the metastable carbide particles will break them down into their most stable structures, *i.e.* ferrite and carbon (graphite). Ha (5a)

A Study of the "Strain-age-hardening" of Mild Steel. C. A. EDWARDS, H. N. JONES & B. WALTERS. *J. Iron Steel Inst.*, Advance Copy No. 5, May 1939, 45 pp. Original research. Both killed and rimmed steels in the form of rods were cold worked
7 by tensile strains and then aged at 250° C. Aging was followed by tensile tests. Particular attention was given to the effects of small amounts of cold work, such as are normally produced at the yield stress of annealed materials, and subsequent aging on the newly acquired yield point. Under these conditions it was found that the yield point after aging was proportional to the yield point of the material in the original condition. This appeared to be true for mild steels of widely different compositions, but the presence of a comparatively small amount of C caused a
8 departure from this rule, because it diminishes the amount of ferrite present. Much consideration was given to the influence of O on strain aging, but all of the evidence indicated that this element had no effect when the specimens were strained under a tensile stress and aged at 250°-300° C. The amount of strain at the yield point was found to be proportional to the magnitude of stress at the yield point. The causes of strain aging and the reasons for a definite yield point in steel are discussed. JLG (5a)

9 **Flame Hardening in the Manufacture of Drilling Equipment.** MICHAEL O'HARA (Internatl. Derrick & Equipment Co.) *Intern. Acetylene Assoc. Preprint*, Mar. 1939, 3 pp. Practical. For the past few years flame hardening has been applied in the manufacturing of shafts, bearing races, clutch jaws, keys and sprocket teeth. This paper deals principally with the hardening of sprocket teeth made from cast SAE-3135 Cr-Ni steel, which have been flame hardened and water quenched very satisfactorily. An automatic flame cutting travograph was adapted to the heating by changing
10 the usual tips and torches. With this method of hardening on this type of steel it is possible to hold the Brinell hardness between 500 and 550 on a production basis. Sprockets hardened in this manner run approximately five times longer than untreated sprockets. CEJ (5a)



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The Strain-aging of Dead-mild Steel Strip Used in the Pressing of Automobile Bodies and Accessories. J. W. RODGERS & H. A. WAINWRIGHT. *J. Iron Steel Inst.*, Advance Copy No. 8, May 1939, 32 pp. Original research. The influence of strain aging upon the tensile and hardness properties of 5 low-C steels, both killed and rimmed, was investigated. Although the effect of aging on the hardness is a simple increase, which other workers have noticed, the tensile results, particularly those of elongation, do not follow the simple changes in hardness that take place. There is considerable evidence for preliminary recovery, a change that takes place in the opposite direction to that usually associated with aging, prior to the major aging change. There appears to be a fundamental difference between hardness and elongation, these properties not exhibiting the degree of complementary relationship usually associated with them. Small fundamental differences were also noted between hardness and maximum strength. Normalizing appears to increase the rate of strain hardening and also produces a more erratic response. The results of a few experiments on the aging of sub-critically quenched steel which had been subjected to cold work are given. JLG (5a)

A New Kind of Salt Bath Furnace with Electrode Heating (Ein neuartiger Salzbadofen mit Elektrodenbeheizung) H. WASSNER. *Elektrowärme*, Vol. 9, May 1939, pp. 89-95. Descriptive. A special type of furnace for case-hardening (Cr-Mo steels especially) in potassium cyanide baths is described, which is said to excel by having high heating capacity and uniform bath temperature. It has the advantage that cheap refractories or even non-heat resisting metals can be used. The electrodes are arranged on one side of the furnace only so that the current does not flow through the part of the bath containing the steel to be heated. The energy consumption of a charge of 200 lbs. of gears at 870° C. was 25 kw.-hr. The electrodes and conductors consist of iron pipes to reduce induction and skin effect in them. Detailed information on the construction is given. Ha (5a)

High-frequency Quenching of Rail Ends. A. MAKHANEK. *Stal*, Vol. 8, Nov. 1938, pp. 46-54. In Russian. Original research. Rail heads were hardened at the ends for a length of 60-500 mm. by heating with an induced 2000-cycle current and quenching with water spray or compressed air. Maximum impact resistance was obtained by quenching to a hardness of 300 Brinell with compressed air. Uniform hardness, depth of quenched case and a uniform transition zone were readily obtained. Rails already in service can be hardened by this method. HWR (5a)

Heat Treatment of Alloy Steels. From now on, we may expect to see many useful data published on the heat treatment of alloy steels, based on their transformation rates as depicted by "S-curves." Such curves are extremely helpful to a more practical understanding of expected properties and structures on cooling such steels at various rates from "quenching" temperatures, and are absolutely essential to the austempering, or constant temperature heat treatment, of such steels. From England comes a report by N. P. ALLEN, L. B. PFEIL and W. T. GRIFFITHS ("The Determination of the Transformation Characteristics of Alloy Steels," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.*, No. 24, 1939, pp. 369-390) giving the results of dilatometric studies on the constant temperature transformation characteristics of alloy steels and showing how the induction period, the rate of transformation and end of transformation may be deduced from such data. From the results of these tests, and from a rather extensive comparison of transformation in alloy and in carbon steels given in another paper (W. T. GRIFFITHS, L. B. PFEIL and N. P. ALLEN, "The Intermediate Transformation in Alloy Steels," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.*, No. 24, 1939, pp. 343-367) several interesting conclusions are drawn. Many alloy steels differ from C steels in that, when cooled continuously and so rapidly that the pearlite transformation is suppressed, they do not always give martensite or mixed martensite and austenite as plain carbon steels do, but may transform in the intermediate temperature range between 550° and 250° C. For this reason it is suggested that the 2 points seen on the cooling curve of a rapidly-cooled carbon steel should be designated Ar′ and Ar ‴, the 3 points sometimes seen on more slowly-cooled alloy steels beng called Ar′, Ar″ and Ar‴. The product of transformation in the intermediate temperature range (Ar″) differs in structure from the product formed at the pearlite point on the one hand and that of martensite on the other hand. The properties also differ, and differ from those of tempered martensite. Transformation in the intermediate range is not unusual during commercial quenching operations, and the properties of a steel after tempering such structures are inferior to those of the same tempered steel in which the intermediate structural product has been prevented from forming during quenching.

Thus, if an alloy steel is likely to transform as it is cooled or quenched through the intermediate temperature range, and if its transformation rate in this range is higher than at pearlite-forming temperatures, it should not be used without tempering—unless the cooling rate happens to be such that fine pearlite is formed. Tempering [at 650° C., incidentally] is shown to improve the properties of steels containing the intermediate structural product. Also, with one alloy steel (Mn-Mo) tested, a sample oil-quenched and tempered at 450° C. gave an impact value of 21 ft.-lbs.; another sample transformed in a Pb bath at 450° C., cooled in air, and tempered at 450° C., gave only 11 ft.-lbs. [These results, and other data in the paper demonstrating the damaging effects of the "intermediate product" on the properties of tempered alloy steels, are not necessarily a condemnation of the applicability of the "austempering" process to alloy steels, although they might hastily be so interpreted. The British workers have traced the constant-temperature transformation course at various temperatures so that structural changes in quenched-and-tempered alloy steels may be better understood. Some of the alloy steels studied, particularly those containing relatively large amounts of Cr, have never been considered for austempering because of their prohibitively long induction periods. Then too, austempering of some of the others is not usually conducted at temperatures as high as those for which comparisons of properties are made in this paper, for the austempered product at such temperatures is known to be inferior. The transformation is always carried out at selected temperatures (usually towards the low side of the intermediate range) where the combination of properties of the austempered steel are better than steel quenched-and-tempered to the same (high) hardness. A tremendous amount of work must yet be done before these optimum temperatures are known for all alloy steels considered to be austemperable.—F.P.P.]

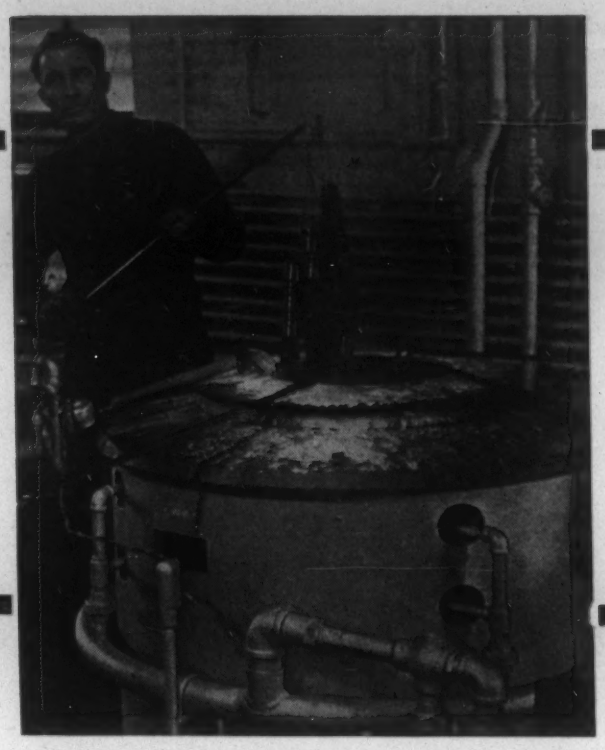
The first paper contains several highly useful curves showing the influence of various amounts of Ni and Cr on the transformation characteristics of steel containing 0.30% C. The transformation behavior of Ni steels is generally similar to that of plain carbon steels, although, of course, the rate of transformation is lower at all temperatures, and the induction periods much longer at low transformation temperatures. Chromium, on the other hand, delays the pearlite transformation and raises its temperature; Cr also delays the intermediate transformation, but lowers its temperature. High-Cr (over 1.8% Cr) steels have extremely long induction periods; low-Cr steels have relatively short induction periods through the whole temperature range studied.

More data on this intermediate transformation in alloy steels are supplied by A. ROSE and W. FISCHER ("Einfluss der Abkühlungsgeschwindigkeit auf die Umwandlungen und die Eigenschaften

der Chromstähle," *Mitt. Kaiser-Wilhelm-Inst., Eisenforsch., Düsseldorf,* Vol. 21, No. 8, 1939, pp. 133-145) based on studies of Cr steels containing 0.25-1.7% C and 0.30-3.7% Cr. Some of the results agree very closely with those of the British workers. Thus, Rose and Fischer find the critical cooling rate considerably lowered by Cr additions and also report such evidently extreme delaying of the intermediate transformation in very high (over 1.65%) Cr steels that, in their tests, such steels showed no evidence of the transformation at all. According to them, however, the mechanical properties of steels with 0.30-0.35% C transformed in the intermediate stage, are better than for normalized steels. [This is not necessarily a contradiction of the British results, and, in fact, tends to substantiate their findings on the undesirability of normalizing certain alloy steels. As previously indicated, constant-temperature transformation of alloy steels *can* give superior results if a suitable (usually low) transformation temperature is selected. The constant-temperature data of Allen, Pfeil and Griffiths were all obtained at temperatures high enough to reveal the damaging effect on the steel of the formation of the intermediate product during slow cooling (normalizing) through the upper portion of the "intermediate" section of the S-curve. —F.P.P.] X (5a)

The Austenitic Grain Size of Steel and Its Coarsening Tendency (Étude sur le Grain Austénitique de l'Acier et son Aptitude au Grossissement) P. BASTIEN. *Rev. Mét.,* Vol. 36, Jan. 1939, pp. 1-11; Feb. 1939, pp. 53-64; Mar. 1939, pp. 101-112; Apr. 1939, pp. 194-201. Review plus original research. Various methods of determining grain size are discussed. The McQuaid-Ehn test is most commonly used, but has many disadvantages: (1) Just one point on temperature-grain size curve is given; (2) carburization may produce other changes (*e.g.* Al may form Al_2O_3); and (3) the grain size determined is not necessarily the one present in the heat treated steel unless quenching temperature is the same as the carburizing temperature. Since a few degrees difference in temperature may make an enormous difference in grain size if the test is carried out near the temperature required for beginning of grain growth, the constancy of carburizing temperature is very important. Experimental data are based on a modified McQuaid-Ehn test wherein the grain size was determined after carburizing for 8 hrs. at 975°, 1025°, 1075°, and 1125° C. Most of the tests were made on 0.35% C steels with duplex and fine grain size. No effect of holding time in the ladle (up to 47 min.) was found. Variations in the amount of hot work from 2-70 (initial ingot section/section after forging) had no effect on the austenitic grain size at 975° C., but the temperature of beginning grain growth slightly decreased with increasing amounts of hot work. Variations in finishing temperature from 650° to 1050° C. had no effect on the austenitic grain size at 925° C., but at 1075° C. the grain size decreased very slightly with decreasing finishing temperature. With increasing amounts of cold drawing from 12 to 86%, the austenitic grain size at 925° C. decreased slightly; while the temperature of grain growth was lower the greater the amount of cold work. After grain growth started, the grain size was larger the less the amount of cold work. Amount of hot or cold reduction and finishing temperature, therefore, affect the austenitic grain size significantly only at temperatures over 975° C., that is, at temperatures above the normal heat treating range. Test pieces taken directly from the ingot had the same grain size at 925° C. as did forged bars from the same ingot. Briefly discussed is the effect of grain size on hardenability, carburization, and mechanical properties. JZB (5a)

Surface Decarburization of Steel (Stålets ytavkolning såsom diffusionsproblem) TORKEL BERGLUND. *Jernkontorets Ann.,* Vol. 123, No. 2, 1939, pp. 54-112. Experimental. Surface decarburization was carried out in bright annealing mixtures of CO, CO_2, and N_2 at 730° C. to 920° C., the mixtures being of such composition as to decarburize the homogeneous γ phase without attacking the ferrite. Gas velocities were very high in order to get rapid interaction between the gas and the C diffusing to the surface of the steel. The rate of reaction at first increases very rapidly but reaches a limit. The rate of reaction is proportional to the C content or more probably the activity of the carbon. The rate is not affected by the Mn content within the limits used in commercial steel. The rate of diffusion of the C does not markedly influence the rate of decarburization except in very low C steel. Maximum rates are obtained with low amounts of CO and CO_2 in approximately the ratio required by equilibrium. The C content decreases rapidly at first but as equilibrium is reached as much as 6 hrs. may be required at 920° C. to bring the C content down to the equilibrium value. Fine-grained steels decarburize somewhat more rapidly than coarse-grained. The effect is assumed to be due to the catalytic effect of dispersed alumina in the fine-grained material. The rate of diffusion appears to increase with the C content in the γ phase. Carbide-forming elements (W, Cr, etc.) slow down the diffusion. Such steels show a much steeper C gradient near the surface. This may sometimes cause confusion when the C content is determined by microscopic examination of the surface. HCD (5a)



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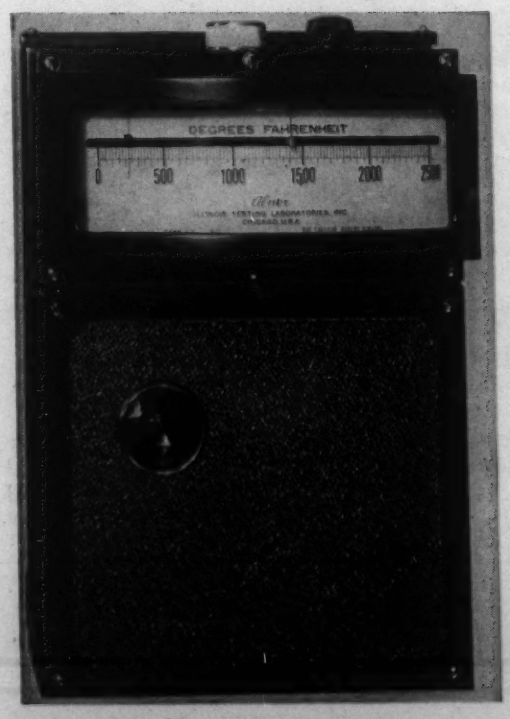

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Age-hardening of Permanent Magnet Alloys. Development during recent years of the precipitation-hardenable permanent magnet alloys, with their sometimes remarkably high coercive forces and residual inductions, and their general freedom from "magnetic aging" effects has introduced a host of new problems for the metallurgical engineer. Among these have been determination of the exact relations between age-hardening manifestations and magnetic properties, inasmuch as the alloys are ordinarily used in the precipitation-hardened state. H. Bumm and H. G. Müller ("Ueber den Zusammenhang der Ausscheidungsvorgänge mit der magnetischen Härte bei Dauermagnetlegierungen der Systeme Eisen-Nickel-Aluminium und Eisen-Nickel-Kupfer," *Wiss. Veröffent., Siemens-Werken,* Vol. 17, No. 4, 1938, pp. 63-73) have studied these relations in Fe-Ni-Al (58% Fe, 30% Ni, 12% Al) and Fe-Ni-Cu (68% Fe, 20% Ni and 12% Cu) alloys, by determining the effect of heat treatment on coercive force, initial permeability, electrical resistance and X-ray structure. In the Fe-Ni-Al alloys decomposition into 2 body-centered phases takes place, when the alloys are in the optimum magnetic condition. In the Fe-Ni-Cu alloys, the maximum of coercive force is attained after the precipitation is completed. The maximum of coercive force corresponds to a certain degree of coagulation of the heterogeneous phase.

The Fe-Ni-Cu alloys were also studied by Otto Dahl ("Ueberlagerung von Kaltverfestigung und Ausscheidungshärtung bei Eisen-Nickel-Kupfer-Dauermagnetlegierungen," *Z. Metallkunde,* Vol. 31, June 1939, pp. 192-203) to determine the effect of the superposition of age-hardening and work-hardening on their magnetic and other physical properties. A special study was made of the precipitation phenomena in relation to plastic deformation. No additional effect of magnetic hardness induced by combining cold work and precipitation hardening occurs. Although cold rolling increases the coercive force of the homogeneous alloy, it reduces drastically the coercive force of the precipitation-hardened alloy, after a minor initial increase. Annealing brings a recovery of coercive force in the temperature range of precipitation. Increasing the amount of deformation accelerates the precipitation and reprecipitation and reduces the maximum coercive force values. Remanence is notably increased by small deformations, but drops on further rolling. Anisotropy was observed in aged alloys. Annealing accentuates this anisotropy, but, on the other hand, it is partially obliterated in the temperature range of decreasing remanence. The Brinell hardness ordinarily obtained with merely age-hardened alloys is increased by superposing work hardening. Electrical resistance is increased very strongly by cold rolling, enough sometimes to neutralize the decrease due to precipitation. Changes of resistivity on annealing are of the same order as those of remanence. EF (5a)

The Superficial Hardening of High Speed Steel. J. GARLAND. *Machinery (London),* Vol. 54, May 11, 1939, pp. 168-171. Practical. For more than 10 yrs., high speed broaches have been treated in molten cyanide at 1050° F. by the author's company; for the past 4 yrs. this treatment has been applied to all sorts of high speed steel tools and dies. A bath of 98% NaCN is maintained at 1050° F. The high speed steel tools are hardened, tempered, and ground as usual; the surface must be free from decarburization and other defects. The tool is then slowly preheated to minimize distortion, and transferred to the cyaniding bath for a time dependent on size (usually about 1 hr.). A cyanide case about 0.001 in. is formed in 15 min.; but 24 hrs. are required for a case depth of 0.005 in. If the case is too deep, the sharp edges may crack. The cyanide treatment increases the surface hardness by 100-300 Vickers or 5-15 Rockwell C. This increased surface hardness is retained up to about 1175° F. The cyanided tools have 1-10 times the life of ordinary high speed steel and bridge the gap between the hardest high speed steels and sintered carbides. JZB (5a)

Modern Pit Design and Practice at Fairfield Works. E. A. HAWK & M. P. BURNS. *Iron Steel Engr.,* Vol. 16, June 1939, pp. 32-43. Furnace design, operation and control are discussed. Low fuel consumption and uniform heating are obtained by: (1) Method of fuel application, whereby sufficient combustion space is available and direction of flame travel prevents impingement of the stock. (2) Recirculation of some of the cooler waste gases, which prevents excessive flame temperatures. (3) Avoidance of infiltration of cold air to the pit and loss of waste gases from the pit, by proper sealing and pit pressure control. (4) Absence of water-cooling losses. (5) Automatic temperature control. (6) Automatic fuel-air proportioning. (7) Automatic pit pressure control, which assures proper pit pressures at all firing ranges, reduces heat losses by closing stack dampers when pit is opened and prevents thermal shock to the recuperators. (8) Proximity of region of heat transfer from waste gases to combustion air to source of application. (9) Checking to insure that recuperators are in temperature balance. CBJ (5a)

Transformation of Residual Austenite in High Alloy Steels at Temperatures Below 0°. A. P. GULVAEV. *Metallurg,* Vol. 14, Mar. 1939, pp. 64-71. In Russian. Research. The transformation of residual austenite at temperatures below 0° C. was investigated with the aid of a specially constructed "austenometer" that was cooled with liquid O. The "austenometer" consisted of a vessel with a primary coil on the outside and a hermetically sealed brass case containing a secondary coil with the specimen and a thermocouple placed inside the vessel. The secondary coil was connected to a mirror galvanometer. Three high-alloy special steels were investigated. Composition: (a) 0.74 C, 18.2 W, 4.01 Cr, 0.58% V; (b) 1.85 C, 10.38% Cr; (c) 0.44 C, 11.0 Cr, 3.85% Si. The steels were hardened by heating at various temperatures and the effects of these temperatures upon the transformation were observed. The results show that the higher the temperature of hardening the lower the start and end of the martensite transformation. The amount of stable residual austenite that remains after the end of the transformation is also greater the higher the temperature of hardening. At room temperature the residual austenite of the hardened steel becomes stabilized, and upon subsequent cooling the transformation does not start immediately but after a hysteresis of 10°-48°, depending upon the length of time during which the samples were held at room temperature. The stabilization at room temperature also decreases the effect of the martensite transformation while cooling to temperatures below 0°. BZK (5a)

5b. Non-Ferrous

Annealing Nickel. Interesting evidence of the consideration that should be paid to the *original form* of nickel when deciding at what temperature it is to be annealed for certain purposes, is found in two recent articles in the same issue of a German magazine. H. G. MÜLLER ("Ueber die Erholung und Rekristallisation von kaltbearbeitetem Nickel," *Z. Metallkunde,* Vol. 31, June 1939, pp. 161-167) studied the recovery and recrystallization of nickel strip made from pressed and sintered carbonyl nickel powder. W. KÖSTER ("Ueber die Wirkung des Ausglühens auf Elektrolytnickel," *Z. Metallkunde,* Vol. 31, June 1939, pp. 168-170), on the other hand, determined similar characteristics for electrolytic nickel sheet.

The carbonyl Ni powder (no analysis) was sintered, hot rolled, annealed at 1000° C. in hydrogen and cold-rolled 90%. Samples were annealed for 1 hr. at different temperatures in hydrogen as well as in a vacuum. X-rays showed the beginning and end of recrystallization to occur at 215° and 250° C. respectively. Grain growth was observed to occur at 1100° C., when annealed in hydrogen, and at 600°-700° C. when annealed in vacuo. The coercive force rises from 46 Oersted for 90% cold-rolled Ni to 48.5 Oersted after annealing at 200° C., and then markedly drops to 10 Oersted at 250° C. No density changes occur on annealing at temperatures up to 600° C., but the density decreases very markedly between 600° and 1100° C., particularly with hydrogen anneals. The maximum volume increase (11%) was observed at 900° C.; above 1000° C. volume changes are almost absent. The hard rolled Ni strips, 138,000 lbs./in.^{2} tensile strength, softened to 111,000 lbs./in.^{2} after annealing at 200° and to 57,000 lbs./in.^{2} at about 300° C. (recrystallization temperature range) while the elongation increased from 1.5% to 30%. When annealing temperatures above 500° C. are used, the effect of annealing atmosphere is notable. Vacuum-annealing at 500°-700° C. and hydrogen-annealing above 800° C. causes a marked loss of tensile strength and elongation. The electrical resistance of cold-rolled Ni recovers on annealing between 150° and 300° C. At higher temperatures, beginning at 700° C. and reaching a maximum at 900° C., a marked increase of resistance, equal to more than 16% of that of the hard worked state, occurs in the vacuum-annealed samples; this increase amounts to only 1.3% in those hydrogen-annealed. Recrystallization does not affect the resistance curve.

Köster's samples of electrolytic nickel, in the form of as-deposited sheet 2 mm. thick, and containing 0.02% C, 0.85% Co, 0.07% Fe, 0.09% Cu and 0.00% Mn, were annealed for 1 hr. at different temperatures. Microscopic recrystallization begins at 500° C. and is completed at 650° C. The hardness, 157 Brinell at 20°, was unchanged by annealing at 400° C., but dropped to less than 80 by annealing at 700° C. Marked loss of tensile strength occurs in the same temperature range, but a further marked loss of strength below that of ordinary, fully annealed Ni takes place on annealing above 700° C. Elongation, reduction of area and bendability are seriously impaired by annealing at temperatures exceeding 500° C. The density begins to decrease at 700° C. and coercive force at 400° C., while the electrical resistance abruptly increases between 600° and 800° C. Hydrogen is liberated as low as 200° C. and most of it has escaped at 500° C., whereas the release of CO begins at about 300° C. EF (5b)

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Tungsten Carbide in Hard Surfacing Oil Well Bits. NOLAN J. CLARK (Reed Roller Bit Co.) *Foote-Prints,* Vol. 11, Dec. 1938, pp. 15-19. **Oil Well Bits.** *Steel,* Vol. 104, Apr. 17, 1939, pp. 76-77. Practical. Rotary rock bits must combine maximum surface hardness or abrasion resistance with maximum toughness. First bits used were made of carburized steel. Then the surfacing of bits with harder materials was developed, using facing-alloys containing Mn, Cr, Mo, Co, W, carbides, borides, nitrides, and cemented W carbides. Finally, fine grain W carbide powder was applied directly to cutting surfaces. This was first done by puddling-up the base metal of the bit with a C arc so that it surrounded W carbide particles, producing a surface containing a large number of small particles of W carbide. A number of other methods have been developed. Judicious additions to steel and regulation of heating methods permit some control of over-all properties of hard-face overlay. Various grain sizes of W carbide can now be applied by either electric arc or torch methods of welding. In all cases, overlay consists of a matrix of some ferrous alloy, either sweated-up from base metal or added in the form of a thin-wall tube filled with carbide particles and melted down around grains. Strong bond results. Fish-tail bits are also being surfaced with W carbide. MS (6)

Modern Aircraft Construction. *Welding Ind., London,* Vol. 7, Mar. 1939, pp. 41-47. Practical review. Resistance welding is now being widely used in aeronautical work in Europe and to some extent in Great Britain. The problems in the application of electric welding to aircraft construction arise from the degree of safety required of structures that are constantly submitted to various stresses; as a rule, aeronautical assemblies may be classed among the metal structures working nearest to the breaking point. Comparative buckling tests on 2 girders, one riveted and one welded, resulted in the spot welded girder collapsing under a load of 3960 lbs. and the riveted one under a load of 3190 lbs. It is claimed that the introduction of d.c. machines working on the decreasing pressure and recompression principle has made it possible to secure welds of uniformly high quality. Experience has shown that when organizing a works for welding aircraft, a satisfactory arrangement is to divide the work into 3 main departments: The first of these departments is to be concerned with the cleansing operations; the second department will be devoted to the drying and storing; in the third department are included the various machines for spot and seam welding. It would seem that hardenable electrolytic-Cu-base alloys are currently the best compromise for electrode metal. With regard to the shape of the electrode, it is important to have them as robust as possible to insure rigidity and a good section for the current flow. The cooling water should reach down to 0.47 to 0.59 in. from the end of the electrode by means of a tube at least 0.31 in. in diameter. The cooling of the machine, when continuously welding light alloys 0.07 in. thick, requires about 14 ft.^{3} of water per hr. When the electrodes have become fouled, work should be stopped at once to clean them. CEJ (6)

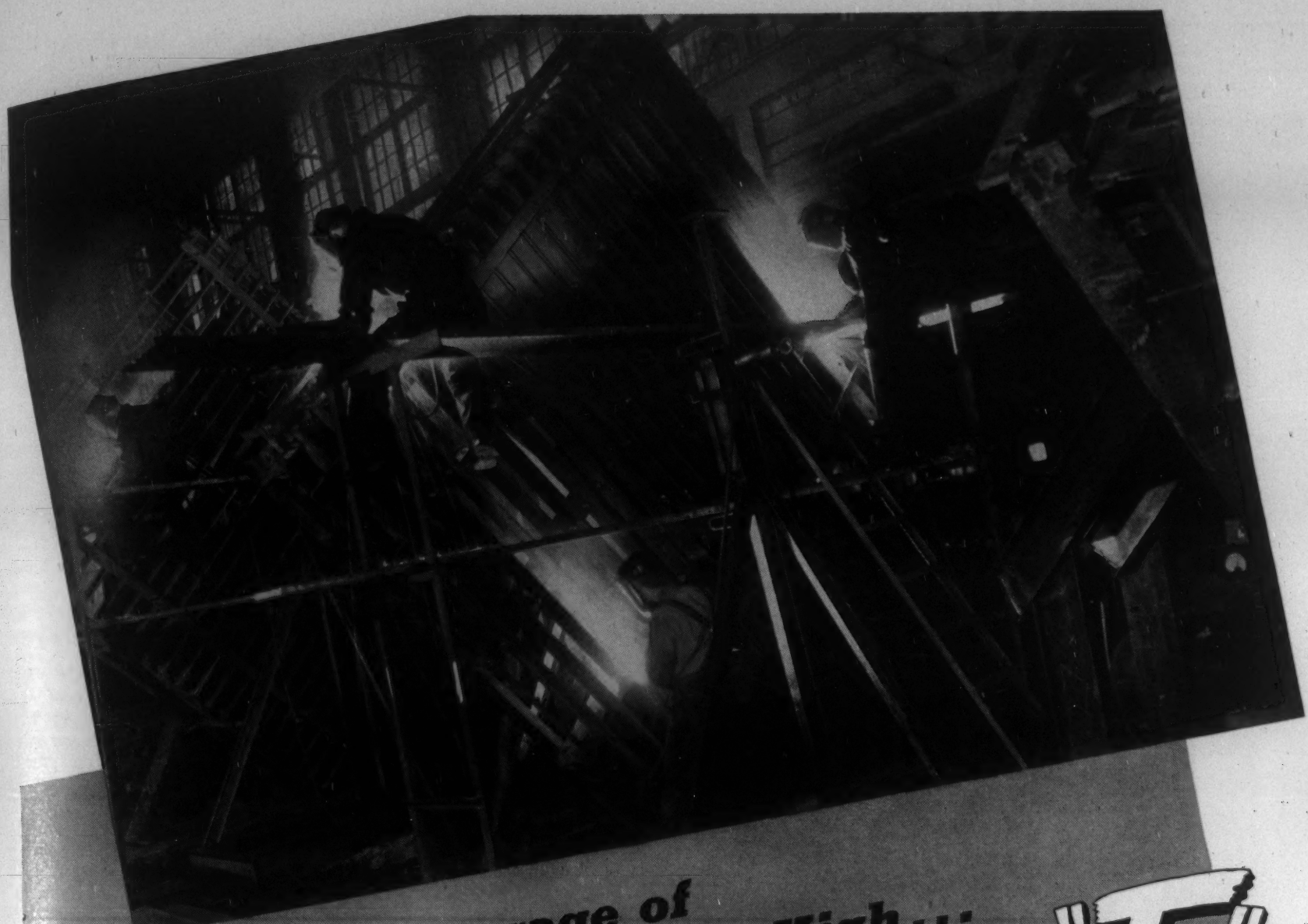
A Survey of the Field of Spot Welding. C. W. LENG. *Sheet Metal Ind.,* Vol. 13, June 1939, pp. 798-801; July 1939, pp. 924-927, 929. Practical review. In spot welds, there are 5 zones: fused, partly fused, zone that was austenitic, zone that was in critical range, unmodified zone. The unmodified zone is particularly important in spot welds of Al, stainless steel, etc. All scale and oxide must be removed before welding; this is particularly difficult for Al. The oxide can be removed with an emery cloth, but the finish is ruined, and the weld must be made within an hour; oxide removing baths do not affect the finish and several days may elapse before welding. Design is very important and should be fundamentally the same as for riveting or bolting; the amount of material around the weld is determined by the mechanical pressure used in the process. Good equipment is necessary; the controller is the brain of the machine and is determined by the type of welding. Duralumin and stainless require a full Thyratron, whereas mild steel needs only a magnetic relay type. Pure Ag is electrically the best for electrodes, but is expensive. Cu is a close second. A harder electrode, such as Cu-Cd, Cu-Cr, Cu-Be, etc., can be used for mild steel; these electrodes have lower electrical and thermal conductivity than Ag or Cu. Special electrodes may be required for certain jobs. Design of jigs, and operating control are discussed. JZB (6)

Testing the Physical Properties of Welds. O. H. HENRY & G. E. CLAUSSEN (Polytech. Inst. Brooklyn) *Welding J., N. Y.,* Vol. 18, May 1939, pp. 288-294. Review, integrating into a small space all the permutations and combinations of tensile, bend, shear, torsion, notch impact, fatigue and other tests on welded joints, weld metal, and overheated zone. The reason for and the application of each test is clearly cited. For example, from the bend test for ductility and determination of weld cracking tendency, information as to inclusion type and content, improperly fused areas or porosity may be obtained. The disadvantages of the free bend test are considered to be the non-uniformity in shape of the specimens assumed at large bend angles, and the possibility of several specimens with the same bend angle having differences in elongation of the face of the weld, or the same elongation with differences in bend angle. The guided bend test overcomes these objections to a certain extent, but the use of a different bending jig with different specimen thicknesses is required. Uniform elongation is not assured by the guided bend but flaws may be detected quantitatively by its use. Soundness tests such as nick and break, density, and others, are reviewed. WB (6)

6a. Ferrous

Modern Methods and Modern Steels in Welded Ship Constructions. P. SCHOENMAKER & G. DEROUY. *Welding J., N. Y.,* Vol. 18, May 1939, pp. 273-276. Practical. A discussion of the favorable results obtained in the arc welding of high tensile steels, which enable the shipbuilder to save considerable weight in construction. Tests were made mainly on two kinds of steel, a Cr-Si-Cu and a Mn-Si-Cu grade with following results: plate strength is of the order of 80,000 lbs./in.^{2}, and for the weld it is 76,000 lbs./in.^{2} It is considered of great practical importance that the yield point of the steel be about the same as the weld metal. Elongation of 28.4% was obtained for weld metal built up for machining of tensile bar. Bend angle of welded plate is 70-75°, but with good and uniform plate quality a good welder may obtain a 180° bend. Impact values of 9-10.3 kg./cm.^{2} for weld and 10-12 kg. cm^2 for plate are averages. Fatigue values for high tensile steels are considered to be so much higher than for the mild steels as to justify the use of the former in ship building. Much of the paper is concerned with details of design of members, types of welds and a review of welding applications to submarines and mine layers since 1937. The savings in costs and weight are discussed and tabulated. WB (6a)

The Trend Is Toward Welded Steel Buildings. VAN RENSSELAER P. SAXE. *Welding Engr.,* Vol. 24, June 1939, pp. 26-27. Practical. In buildings of 3 or 4 stories where there is no danger of sway during erection the author has found it more economical to shop-weld supporting beam seat members with sufficient welding to support the entire beam reaction, using only two bolts in top and bottom of connection angles. No field welding is required. This is similar to the average riveted column seat, field-bolted job. If it is desired to get a more rigid structure, the flanges of beams can be field welded to the supporting seat members. For buildings requiring a more rigid construction, the type of connection in which a light angle is used as a seat for erection purposes only is preferred, the beam web being welded direct to the supporting member. Shop requirements for assembly of a welded job are much simpler than for a riveted job. Field erection costs, using union labor and field erection bolts for the multiple-story welded beam and girder building, average about the same as for a riveted job. CEJ (6a)



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Economics of Machine Gas Cutting. G. M. DEMING (Air Reduction Sales Co.) *Intern. Acetylene Assoc.*, Preprint, Mar. 1939, 11 pp. Practical analysis. The oxygen cutting process has effected such remarkable savings in the production of steel shapes from sheets, slabs, and billets, that serious attention has only recently been directed toward reducing operating costs of the process itself. For all but thin articles the cost of the cutting operation is so small that a rough but frequently useful approximation of the aggregate cost may be obtained merely by adding the cost of the steel actually utilized to the loss involved in the scrap. For a wide variation in the thickness and the area-length ratio represented (from 1 to 8), variation in cutting cost is from 4 to 120% of the steel utilization cost. The average is apparently on the order of 30%. Of the various detail costs, the one most likely to vary widely in practice is the cost of the steel actually utilized in the oxygen-cut article. Scrap depreciation is ordinarily one of the principal items in the cost of the cutting operation. It is therefore very important, where a great variety of parts are being cut, that every effort be made to utilize the scrap material from one part for smaller parts. The use of multiple torch cutting will by no means reduce the labor cost in direct proportion to the number of torches, however it will effect a substantial saving. Stack cutting, when feasible will also reduce labor costs. Overhead is usually figured as a percentage of labor cost. Cut quality is a matter of primary importance when considering economics of machine gas cutting.

The most important conditions that must be maintained in the interest of smooth cuts are: Uniformity of torch movement, uniformity of oxygen-pressure regulation (important for heavy thicknesses), uniformity of steel being cut, smoothness of cutting orifice, cleanliness of orifice exit, sufficiently high oxygen purity, sufficiently low oxygen operating pressure, sufficiently low operating speeds for light and moderate thicknesses, and sufficiently high operating speeds for heavier thicknesses. Aside from the fundamental conception that excessive oxygen tends to eliminate adhering slag it should be understood that a lightly adhering slag is favored by the following conditions: Cleanliness of cutting orifice exit, smoothness of cutting orifice, high purity of oxygen, scale or rust along the bottom edge of the material cut, sufficiently high oxygen operating pressure, sufficiently large tip, sufficiently low cutting speed. The increase of oxygen consumption becomes greater as the length of drag decreases, and for very short drags a very greatly increased oxygen consumption is required to produce a slight decrease in the drag length. The shop without some criterion of cut quality related to length of drag will almost certainly experience excessive costs for its cutting operations. It is not always desirable to attain the maximum possible oxygen efficiency, as over-all efficiency is not necessarily parallel. The greatest possible advances in promoting the economy of oxygen-cutting appear to consist in better utilization of the steel, particularly through better planning of the cut contours to adapt them to sizes and shapes of steel ordinarily available. CEJ (6a)

Britain's First All-welded Warship. *Welder*, Vol. 11, Apr. 1939, pp. 111-114. Descriptive. H.M.S. "Seagull," which was laid down in Feb. 1937, was one of two minesweepers ordered to be built at Devonport Dockyard. It was built completely by welding, with an overall length of 245 feet and a displacement of 875 tons. The welding equipment consisted of 4 thirty kw. portable motor generator sets, converting 380/440 volts a.c. to 50 volts d.c. From 20 to 40 welders obtained their electrical supply from link-boxes along the side of the slip, each welder having his reactance and resistance on racks besides the ship or on deck as the work progressed. Ground connections were made by a cable running the full length of the ship and joined to permanent ground clamps. As the entire ship was built of mild steel, mild steel electrodes were required, which could be used successfully in all positions. The ship was welded throughout except for plating under 5 lbs. thickness. Welding was continuous except where intermittent welding was specified. The laps of all plates were welded with full fillet on one edge of the lap and a light fillet on the other. Full advantage was taken of the possibilities of saving weight by the use of well-designed welded connections. On all continuous lengths of welding the "step-back" method was used. This method tends to distribute heat and avoid distortion. For such continuous lengths, the welding was started at the middle of the length and worked towards the ends. As far as the framing was concerned, the lightened plate frame holes were cut after the welding was completed, in order to reduce distortion. The system of working outer bottom plating was from amidships towards the ends. CEJ (6a)

Applications of Thermit Welding. E. DACRE LACY. *Metal Treatment*, Vol. 5, Spring 1939, pp. 23-28. Descriptive. The most commonly used mixtures are plain thermit, consisting of Al powder and iron oxide; forging thermit, containing additions of Mn and mild steel punchings, for welding steel; cast-iron thermit, containing ferro-silicon and mild steel punchings; and wobbler thermit, for building-up worn wobbler ends. The parts to be united are held slightly apart by wax, which is built up to form a pattern of the reinforcement required, and a sand mold formed around this and suitable riser, pouring-gate, and preheating gate patterns. The mold is preheated until all the wax runs out, and a magnesite-lined crucible containing the thermit mixture placed in position. The mixture is set off with ignition powder, which is preferably ignited by a red-hot steel rod. When the noise of the reaction dies down, the metal is tapped. The main use of thermit welding is for rails. The German railways have 400,000 joints in service, including those in one continuous length of 6,560 ft.; satisfactory results are being obtained in France, Australia and England; and since 1934, the use of long lengths of welded rails has extended in the U.S.A. Tensile tests on thermit-welded 2 in. mild steel bars showed no reduction in strength or elongation; in bending tests, fracture occurred at the weld after bending 46° when the bulb was machined off. When the bulb was left on, the bars could be bent as far as practicable (125°) without cracking. JCC (6a)

Welding High Pressure Piping. ARTHUR N. KUGLER (Air Reduction Sales Co.) *Welding J., N. Y.*, Vol. 18, May 1939, pp. 300-302. Practical. Piping thicker than ½-in. wall is considered as high pressure piping. The backhand method of gas welding is superior to the forehand method since higher values for free bend, reversed bend and nick break tests, are obtained with tensile strength about equal for the two methods. The use of multilayer welding with the torch, consisting of one layer for each ¼ in. thickness of the pipe is shown by experience to have reduced consumption of welding gases and rods because of the reduced size of the melted puddle and lessened depth of fusion. Reduction in welding time and cost reductions of 15 to 25% are reported. The highest quality weld is produced by the multilayer method. For C-Mo steel piping with 0.10-0.20% C and 0.45-0.65 Mo a new method of welding has been developed for which an oxyacetylene rod of C-Mo analysis has been made available. The method consists of multilayer welding with backhand technique, which requires no preheating as is necessary for arc welding. A greater number of layers are used for the C-Mo pipe with the new technique, 5 layers per ⅞ in. of thickness. Stress relieving is done either with the torch or portable furnace fired with city or natural gas and air. In one recent installation on extra heavy pipe the weld and adjacent pipe were heated to 1450° F. and cooled slowly by wrapping with insulating material. The results were excellent grain refinement in the weld and increase in ductility without serious loss of tensile strength. WB (6a)

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Investigations into the Suitability of Commercial Welding Wires and Electrodes for Oxyacetylene Welding in Boiler Construction (Untersuchungen über die Brauchbarkeit von im Handel befindlichen Schweissdrähten und Elektroden für Schweissverbindungen im Kesselbau unter Verwendung der Azetylen Sauerstoff Flamme) WEIDLE. *Autogene Metallbearbeit.*, Vol. 32, June 1, 1939, pp. 165-174; June 15, 1939, pp. 181-191; July 1, 1939, pp. 198-208. Unusually comprehensive review of the materials used for boilers and the materials used for welding them. To assure good welding properties, low C alloy steels are used preferably, with not more than 0.35% C. Tests were made with boiler plate with 0.08 C, 0.35 Si, 0.46 Mn, and less than 0.01 S, 0.01% P, and of 15 and 25 mm. thickness; structure, bending strength, hardness, notch-impact and appearance of the seam were tested at each step and the results given in numerous tables and curves; 11 wires and 11 different coated electrodes were used. All welds were made with neutral flame and right hand procedure. The results for the practice can briefly be summarized as follows: Gas welding, even with good wires, is not considered reliable for boiler plate above 10 mm. thickness. In order to improve the quality of oxyacetylene welds, the composition of the wire must be carefully selected. Coated wires give better results and improved weld structure, because of the low heat-conductivity of the slag formed on the weld. The welding procedure should be adapted to the material of the welding wires to utilize to the full their properties. Subsequent heat treatment if necessary should bring out or restore the qualities of the parent material and weld. Important in practice is the economy of the process; multiple-flame burners seem to aid economy, in particular for thick plate, as the welding time is shortened. Preliminary tests are recommended in case of doubt as to the best procedure and heat treatment to apply. 36 references. Ha (6a)

6b. Non-Ferrous

Spot Welding Technique for Aluminum and Light Alloys. *Welding Ind., London,* Vol. 7, Mar. 1939, pp. 72-74. Practical review. The spot welding of Al and other light alloys presents many difficulties in practice. With the development of the new condenser spot welding machine, these difficulties are claimed to have been effectively overcome. The new technique incorporated in this machine is claimed to give perfectly regular operation with welds of excellent quality, and a tremendous reduction in the load required for light alloy welding. Light alloys melt at fairly low temperatures, and their welding temperature is close to their melting temperature. In view of the high heat and electrical conductivity of these alloys, the amount of heat actually generated by the passage of the welding current is comparatively small, while the heat losses are high, factors which necessitate the use of heavy currents. The welding of Al alloys demands current densities as high as 2,000-3,000 amps./mm.^{2} The principal lines of development that have been followed to overcome these difficulties have had as their object the building up or storing of the necessary power during a comparatively long period in order to release it under accurate control during the brief time occupied by the welding operation. The action of the condenser machine consists of 2 separate operations: (a) The charging of the condensers, and (b) the discharge of the condensers through the primary of a transformer. To produce in the secondary a current of 20,000-50,000 amps., it is only necessary to vary the charging voltage from 300 to 500 volts. The production speed obtainable is ample for aircraft and similar work, and the charging period is usually arranged to occupy approximately 0.3 of a sec. Machines are usually arranged with a loading that gives 30 spots per min. CEJ (6b)

Electrical Resistance Welding of Light Metals (Die elektrische Widerstandsschweissung von Leichtmetallen) K. SIEMERS. *Elektrowärme,* Vol. 9, Apr. 1939, pp. 75-83. Practical. The light metals, Al, Mg, and their alloys, can be welded by simple butt-, spot- seam-welding and fusion welding; spot-welding is the most commonly applied. The metals are heated to a pasty state; the heat applied must be very carefully regulated. Control equipment for correct adjustment of current, and the effect of the physical, mechanical and chemical properties of the metals to be considered in welding are discussed at length. Welding machines for spot- and seam-welding are described. Ha (6b)

Arc Welding of Aluminum. A. F. DAVIS (The Lincoln Electric Co.) *Sheet Metal Worker,* Vol. 30, June 1939, pp. 27-30. Descriptive of welding technique. The electrode covering fluxes the Al_2O_3 formed during welding and acts as a protective coat over the molten weld metal. Preheating may be necessary to get sufficient heat into the work. For best results the electrode is connected positive and the arc should be short. Directions are given for lap, vertical and overhead welds. Tables give the data (electrode size, speed, current, etc.) for various types of welds. PCR (6b)

7 Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

Modern Methods of Acid Pickling. R. SAXTON. *Sheet Metal Ind.,* Vol. 13, June 1939, pp. 763-764. Practical. HCl is sometimes used as a preliminary pickle, but 6-8% H_2SO_4 is most usual. Prior to tinning, 2 pickles are required: the first to remove foreign matter from the surface and to give an etched, non-oxidized surface for good bonding; the second after annealing is a "white pickle" in 1.5-3% H_2SO_4 at 60° C. Electro-pickling is more expensive, but gives a better finish with lower acid consumption. Stainless sheets require different solutions: (1) hot H_2SO_4 followed by cold 20% HNO_3; (2) 5% HNO_3 + 25% HCl at room temperature; (3) 50% HCl, 5% HNO_3 + 0.25% inhibitor at 50°-60° C. (particularly suitable for descaling sheet edges prior to welding). Inhibitors are now almost universally used. A new electrolytic pickle uses fused Na salts, with the material to be cleaned connected as the cathode. "Nascent" Na is liberated, which reduces the oxides to metallic Fe. This method has the following advantages: (1) there is no material loss; (2) there is no H_2 embrittlement; (3) pickling can be combined with heat treatment or stress relieving if Na salts of suitable melting points are used; (4) cleaned sheets are less likely to corrode than are sheets given an acid pickle. JZB (7)

7a. Electrolytic Methods

Electrolytic Pickling of Strip Steel. H. W. NEBLETT (Inland Steel Co.) *Iron Steel Engr.,* Vol. 16, Apr. 1939, pp. 12-20, 30. Descriptive. Experimental development of electrolytic pickling of strip steel is discussed. The usual continuous pickling line consists of 4 acid bath tanks, each 60 ft. long, in series. Tank No. 1 is used as a conditioning tank to allow the acid to penetrate the scale, tank Nos. 2 and 3 have electrolytic equipment and remove approximately 98% of the scale, and tank No. 4 is used as a clean-up tank. The top electrodes are made up of a cast lead form in which are embedded two 3 in. x 1 in. copper bars for current distribution; this frame is covered with sheet lead containing 8% Sb. The bottom electrodes are flat sheet of 8% Sb-Pb rolled 1½ in. thick. These electrodes rest on the bottom of the tank. At points throughout the area of the bottom electrodes, holes are cut and bricks protrude 4 inches above the surface. These serve as supports for the steel strip. Terminals connecting to the electrodes must be well insulated to prevent current leakage and electrolytic action. Glass fabric tape impregnated and sealed with a synthetic compound is used. Experiments on graphite electrodes are promising. A roller assembly to prevent the steel sheet from coming in contact with the top electrode consists of a roller with extended shaft, made of a resinous base and asbestos binder compound, fitted with glass bearings. To realize the full advantage of this increase in speed, from electrolytic pickling, and to secure an increase in tonnage, the pickling line as a unit must be able to operate in the time required for a coil to pass through the pickle bath. If this condition does not exist, the time saved will be offset by delays due to preparing a new coil for feeding into the pickle line. CBJ (7a)

Anodic Films on Aluminium and Its Alloys for Protection Against Corrosion. J. W. W. WILLSTROP & H. SUTTON. *J. Electrodepositors' Tech. Soc.,* Vol. 15, 1939, Preprint, 16 pp. Original research. The Bengough-Stuart anodizing process was carried out with different applied voltages, in a 3% CrO_3 solution at 40° C. The thickest films (wt. = 4 g./m.^{2}) were obtained at 70-80 v. The films formed at 50 v. were slightly thinner (wt. = 3 g./m.^{2}), but much less electrical energy was consumed in their production. A still bath yielded thicker films than one that was agitated; however, a moderate agitation was advisable for the maintenance of uniform bath temperature. The effect of a.c., d.c., and superimposed a.c. and d.c. on the anodizing of Al and duralumin was studied. With the 3% CrO_3 bath, a.c. alone produced no film, and superimposed a.c. and d.c. had no advantages over d.c. alone. Anodizing in oxalic acid (2-8%) solutions or H_2SO_4 solutions (16%) yielded good films with either a.c. or d.c. alone, and with superimposed a.c. and d.c. The loss in wt. of metal in the H_2SO_4 solution was larger than in the CrO_3 solution (0.1-0.3 g./dm.^{2} as compared with 0.005-0.02 g./dm.^{2}). In a sea water corrosion test, duralumin anodized by the Bengough-Stuart process showed greater corrosion resistance than specimens of the same material anodized in oxalic acid solutions. Steaming improved the protective value of the oxalic acid films but decreased the protective value of the B-S process films. Mechanical tests, which were made on anodized specimens before and after a corrosion test, showed that the B-S process films were slightly superior to the films produced in H_2SO_4. The authors discuss the increase in the protective value of the films produced by applying grease or varnish. AB (7a)

Electrodeposition of Silver-lead Alloys for Bearings. CHARLES L. FAUST & BEAUMONT THOMAS (Battelle Memorial Institute) *Trans. Electrochem. Soc.,* Vol. 75, 1939, Preprint No. 18, 12 pp. Original research. A Ag-Pb alloy containing 3-4% Pb is a good bearing metal, but it can not be readily bonded to the steel bearing-back by casting. Better adhesion can be obtained by electrodepositing the alloy on to the bearing-back, especially if the latter has been coated in a CuCN and AgCN strike. An alloy bath containing AgCN and sodium plumbite gave good deposits, but it was not stable. The percentage of Pb in the deposit increased as the bath aged. The best results were obtained with the following bath: KCN, 22 g./l.; AgCN, 30 g./l.; potassium tartrate, 47 g./l.; KOH, 0.5 g./l.; lead acetate, 4 g./l. The anodes were a Ag-Pb alloy containing 3.8% Pb. They dissolved without sludge formation. The current density was 7-15 amp./ft.^{2} in a stirred bath. The deposits had a Vickers hardness of 126, which was lowered by heat treatment. (The deposits from some of the preliminary baths were too hard to be used for bearing metal.) Deposits several hundredths of an in. thick were plated and the bath was stable on continued operation. The metallographic examination of cast Ag-Pb alloys, containing about 4% Pb, showed the Pb to be distributed between dendrites or along grain boundaries. There was no visible structure or segregation of Pb in the electrodeposited alloys. AB (7a)

The Effects of Cadmium and Arsenic in Nickel Plating Baths (Die Wirkungen von Cadmium und Arsen in Nickelbädern) M. WITTUM. *Mitt. Forsch. Inst. Probieramts Edelmetalle,* June 1939, pp. 13-17. Research. Cd is added to Ni baths to produce bright deposits, but nowadays is often replaced by organic substances that give greater brightness and better uniformity of the deposit. The best Cd content seems to be about 0.3-1.6% with a bath pH of 6.8. Cd and Ni are deposited together from a bath with high Cd content; the deposits of the alloy are soft and adherent, and have the color of Cd. Ni baths, with increasing As content, show decreasing cathode potential, and the deposits from such baths often contain considerable hydrogen. The increased H development makes the bath in the neighborhood of the cathode quickly alkaline, and finely distributed nickel hydroxide is precipitated with traces of As, which covers the whole bath surface as a fine film. The color of As-containing Ni deposits is irregular, dull gray for low As contents at room temperature, becoming bright and streaky and brittle for high current densities; no practically usable deposits could be obtained. The development of poisonous AsH_3 on the cathode requires great caution in the operation. 7 references. Ha (7a)

Electroforming with Iron—the Ekko Process. ARTHUR W. BULL, J. W. BISHOP, M. H. ORGAUGH & E. H. WALLACE (U. S. Rubber Co.) *Ind. Eng. Chem., News Ed.,* Vol. 17, July 20, 1939, pp. 461-464. Descriptive. A new method, called the Ekko process, has been developed for producing molds and dies by the electroforming of iron. By this process molds may be duplicated or produced from objects or patterns. Applications to a wide variety of industries such as rubber and plastic molding, ceramics, metal stampings, jewelry, silverware, and glass are being made. The process offers quick and perfect reproduction of the most intricate details, usually with a great saving in cost. By its use designs available in one material, for example, carved ivory, can be used to produce molds in which the original design may be duplicated in other materials, such as glass or plastics. Molds or embossing plates to reproduce natural surfaces, such as leather grains, can be readily made. By hardening the iron the process can be extended to many types of dies and punches for metal stamping. By combination with a special photographic process, iron molds with photographic likeness to the original may be obtained. Numerous diagrams are given to illustrate the applications of the Ekko process, but the composition of the bath is not disclosed. MEH (7a)

Impurities in Plating Solutions. VINCENT MATTACOTTI. *Metal Ind., N. Y.,* Vol. 37, June 1939, pp. 259-264. Practical. Plating salts making up a bath may act as sources of undesirable materials; Fe, Pb, Cu, Zn, and Cd may be introduced. Impurities may be introduced from the equipment such as organic matter from wood tanks, oil contamination, and corrosion from steel. Impurities are also introduced from the anodes used and from the water used in making up the solutions. Organic impurities such as glue, dextrin, resin and saps from wood or fabrics give hard deposits in Ni solutions and give erratic effects in Zn solutions; they coarsen the grain structure in Ag solutions, refine the grain and increase the hardness in Cu baths. The introduction of Fe in Ni solutions increases hardness and decreases throwing power. Cu, Pb, Zn, and Cd all affect the deposits. Inorganic oxidizing agents such as peroxide, perborate or permanganate reduce the efficiency and throwing power, and may also cause temporary hardness. Copper and Pb produce dark plates in Cd and Zn. Silver or Cd leads to roughness and to the formation of tree-like deposits in Cu baths. Porosity of the plate may be due to suspended matter, such as buffing dirt, insoluble salts, etc. Methods of removing impurities are discussed. CBJ (7a)

Brush Plating. *Iron Age,* Vol. 143, May 4, 1939, p. 39. Practical description of brush electroplating process developed by Portable Plating & Equipment Co. which is comparable in principle to the tank immersion method with the exception that the solution is in a thickened or colloidal condition. Plating takes place only where brush is directed, and the longer the brush is applied with enough solution, the thicker the deposit. Increasing the size of the anode located in the brush, results in greater current efficiency, and more rapid deposition. Equipment may be plated without dismantling. Includes an electrodeposition chart for brush plating with various solutions. VSP (7a)

7b. Non-Electrolytic Methods

Iron and Steel Descaled and Structural Steel Cleaned by Oxy-acetylene Process. J. G. MAGARTH (Air Reduction Sales Co.) *Iron Age,* Vol. 143, Apr. 20, 1939, pp. 34-39. Practical description of recent developments in flame descaling in which scale is removed by rapidly heating with multi-flame oxy-acetylene tip. Process consists in using an oxidizing and blasting flame. By sweeping flame over small areas, the expansion effect of the heat and blast of the flame loosens and removes scale that consists largely of burnt sand and metallic oxide. Nature of scale formed on heated surfaces has been the subject of much discussion. Recent studies indicate that 3 layers, containing up to 4 phases, are found in scale produced on Fe at high temperatures in an air atmosphere. They are: (1) Thin layer of Fe_2O_3; (2) thick layer of Fe_3O_4; and (3) decomposed Wüstite phase. In alloy steels there results in many cases a difference in constitution of scale deposit. Decomposed Wüstite phase should not be found where scale is produced at a temperature below 1100° F. Fe_3O_4 predominates in scales formed in air atmosphere, while scale formed in steam, CO_2 and mixtures of these with or without CO_2 or H_2 at 2000 to 2500° F. consist largely of FeO. Ease of scale removal is not measurable by its thickness. Flame descaling leaves a clean, natural surface. There is no physical action upon, or discoloring of, base metal. Flame cleaning and dehydration of structural steel is being subjected to practical tests. In theory, occluded moisture on scaled steel surfaces creates a condition favorable to loosening of mill scale that would otherwise remain tight. Gradual loosening of scale, owing to presence of moisture, causes flaking off of paint. By quickly passing high-temperature flame over the surface, occluded moisture is driven from within and beneath scale, leaving warmed surface that provides good paint adherence. It is not necessary to remove all the scale, but only that which will separate under concentrated action of flame. After application of flame, surfaces are hand wire-brushed. Cleaning with compressed air is not permissible. Painting follows while steel is warm and in no case is paint applied more than 2 hrs. after flame cleaning and dehydrating. VSP (7b)

"Copperheads" (Kupferköpfe) H. HADWIGER. *Emailwaren Ind.,* Vol. 16, Mar. 3, 1939, pp. 62-64. Research. After referring to the results of previous investigations, in particular the American investigations by Rosenberg and Canfield who found that copperheads are caused by local accumulation of Fe oxides, the author outlines results of his own investigations, which also prove that the fault is due to Fe oxides. Careful pickling is of prime importance to eliminate this enameling trouble. Pickling residues leading to accumulation of Fe oxides in pores of the

sheet surface must be removed by careful and sufficiently long washing and gradual decrease of acid concentration. Certain relations exist between "fish scale" and "copperheads." (See also recent German investigations on the relation between fish scale formation and hydrogen, *Metals and Alloys,* Vol. 10, Feb. 1939, p. MA 106 R/1. GN (7b)

The Treatment of Magnesium Alloys in Hot Chromate Baths. E. G. SAVAGE. *J. Electrodepositors' Tech. Soc.,* Vol. 15, 1939, Preprint, 8 pp. Descriptive. Protection of Mg and its alloys by sherardizing, metal spraying, or electrodeposition has not been satisfactory. Better results are obtained by chemical immersion treatments. Two chromate immersion treatments developed by the Royal Aircraft Establishment, Farnsborough are described. One process that required a 6-hr. treatment has been largely superseded by a 30-min. process. The bath for the latter consists of $(NH_4)_2SO_4$, 3% by wt.; ammonium dichromate, 1.5%; $K_2Cr_2O_7$, 1.5%; ammonia (sp.gr. 0.880), 0.35% by vol.; pH = 5.8-6.4 (brom-cresol purple range). The bath is operated at the boiling point. The pH at which the best results are obtained varies with the nature of the alloy. If the bath is too acid, the coatings are loose; if too alkaline, the coatings are thin. Preparatory to the coating treatment, the parts are cleaned by a 10 sec. dip in 5-10% HNO_3 or H_2SO_4, or by 20-30 min. immersion in a boiling alkaline cleaner. Coatings may be stripped in a hot strong CrO_3 solution or by immersion in the following pickle; HNO_3 (sp. gr. 1.42) 1 part by vol.; fuming HNO_3 (sp. gr. 1.5), 1 part; nitrobenzene, 9 parts; CCl_4, 1 part. The areas of the specimens that are not to be coated are "stopped off" with rubber. The chromate solutions are preferably contained in Al tanks, but iron tanks may be used. The chromate coatings are usually covered with paint or varnish. AB (7b)

Fish Scales in Ground-coat Enamel (Fischschuppen in Grundemails) J. KLÄRDING. *Stahl u. Eisen,* Vol. 59, Mar. 2, 1939, pp. 268-271. Original research. On the assumption that fish scales are due to entrapment of gases evolved in firing the enamel coating, 8 enamels were fired at different temperatures and the tendency to fish-scaling observed. Tests were also made of the viscosity of the different enamels at firing temperatures from 800° to 1200° C. The firing temperature for each enamel must be below a certain temperature in order to give a good appearance. Tensile tests were also made of filaments of the various enamels. No relationship was found, however, between the tensile strength of the enamels and their tendency to form fish scales. SE (7b)

8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

A Study of the Influence of Speed on the Torsion Impact Test. O. V. GREENE & R. D. STOUT (Carpenter Steel Co.) *Am. Soc. Testing Materials,* Preprint, June 1939, 7 pp. Research. Further experiments on the effect of velocity in torsion impact testing of hardened 1.10% C tool steel are given (see also *Metals and Alloys,* Vol. 5, July 1934, p. MA 344; Sept. 1934, p MA 458; Vol. 7, Mar. 1936, p. MA 146). A range of speeds is investigated on the torsion impact machine and on a static torsion machine. The modulus of torsion was found to be about 10,800,000 lbs./sq. in. The torsion impact values were found to be consistent over the range of speed investigated—700 r.p.m., 73 radians/sec.; 100 r.p.m., 10.5 radians/sec.; 15 sec. test, 0.1 radians/sec.; 10 min. test, 0.001 radians/sec. Both impact and static tests show the same shape of curve when breaking energies are plotted against drawing temperature, but at temperatures below 400° F. values decrease as speed of test is decreased. (The range of drawing temperatures was from 212° to 800° F.) For drawing temperatures above 400° F. there is a good agreement at all velocities of testing. An explanation is offered to account for the low breaking energies obtained with low testing speeds for drawing temperatures below 400° F. It is suggested that the application of stress encourages the tendency of austenite to decompose to a less ductile structure, which, however, involves a definite time factor. The extent of this action is thus dependent on the duration of test, which, if short enough, causes it to become negligible and permits the full cushioning effect of the austenite. The results indicate that the torsion impact test is essentially a rapid static test. VVK (T-8)

The Testing of Bearing Metals for their Running Properties (Die Prüfung von Lagermetallen auf ihre Gleiteigenschaften) E. VOM ENDE. *Metallwirtschaft,* Vol. 18, May 19, 1939, pp. 423-427; May 26, 1939, pp. 443-444. Review. Bearing metals must prove themselves under widely varying conditions in practice. These are determined by the intensity and type of bearing load as well as shaft speed, in combination with the form of the bearing and the exactitude of its production. An important role is played by the nature of the surface layers of the journal and bearing with relation to film formation. As the lubricating film is an adsorption film and the testing of bearing metals takes place essentially in the range of limiting lubrication, the molecular physical properties of the lubricant and the properties of the metal that influence them must especially be considered. A practical test of metals requires the measuring of the friction moment, the bearing temperature, and minimum lubricating film thickness. Impact properties are also to be considered. Metals with a heterogeneous structure have better film forming properties than homogeneous alloys. Cold working of a homogeneous alloy by forming slip lines will improve bearing or glide behavior. GA (T-8)

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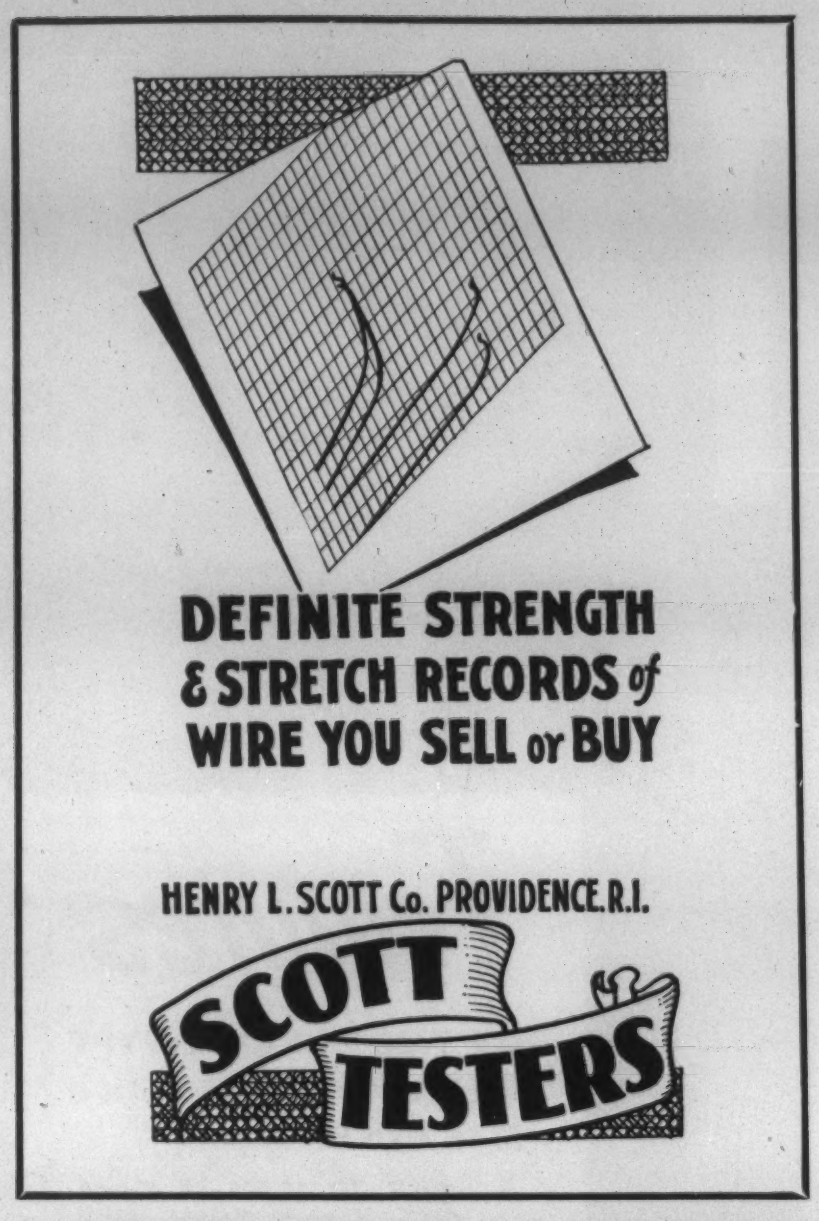

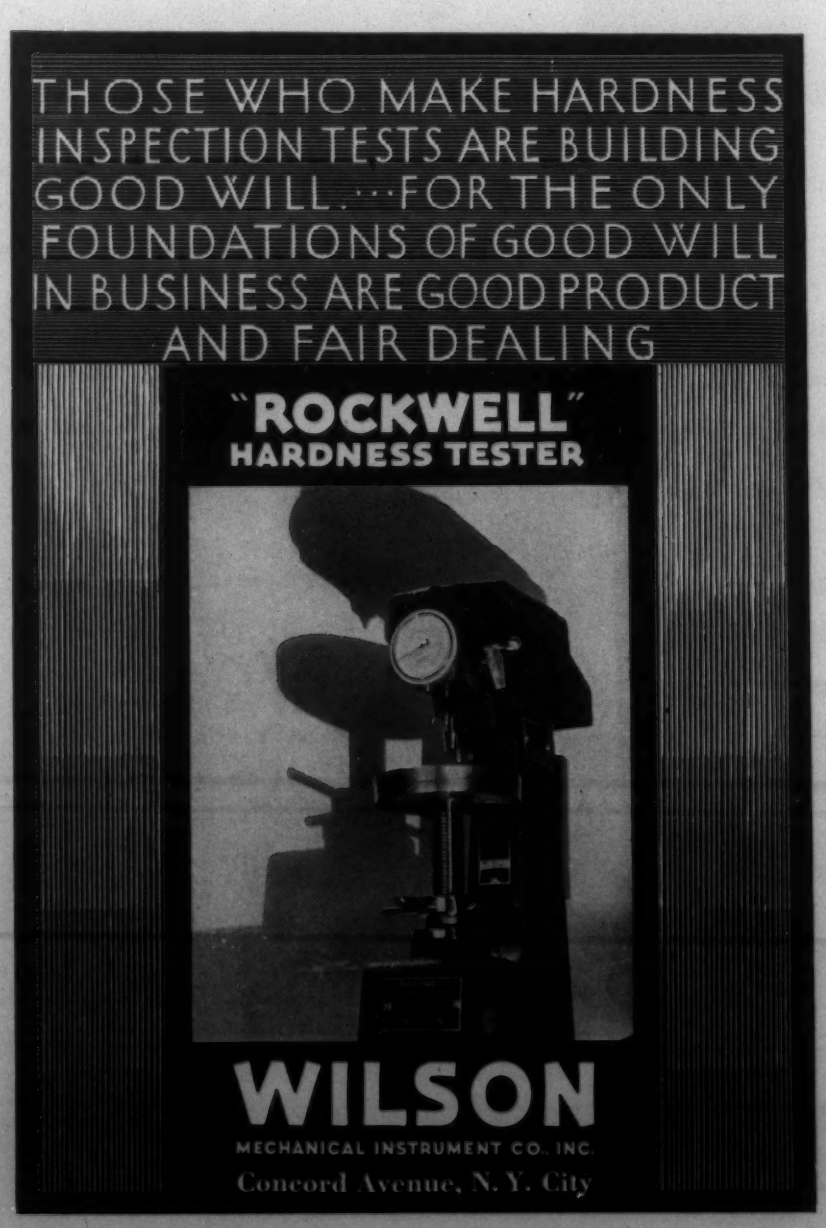

Spectrographic Analysis of Light Metals. New applications for spectrography in controlling plant operations, in examining engineering materials before use, and in research, continue to appear. Aluminum and Mg alloys are as fair game as others for the stalking spectrographer. J. R. HANDFORTH, H. W. WHYMPER and W. M. BOULTON ("Spectrographic Analysis and Its Application to Aluminum Alloys," *Metal Treatment*, Vol. 5, Spring 1939, pp. 3-12) describe equipment and methods used at the Birmid Industries plant in England for routine determination of Mn, Mg, Si, and Fe in Al alloys. In one shift, 2 operators examine 60 samples of duralumin for the 4 elements, with results equal in reliability to those from wet chemical analysis. A non-recording photometer is used to measure the intensities of selected lines, one an Al line and the other chosen from the spectrum of the element under consideration. The logarithm of the ratio of the 2 readings is independent of the development conditions of the plate and forms a quantitative measure of the amount of the minor element present. Calibration curves are made, using carefully analyzed alloys closely comparable in composition with those to be measured, at least 5 points being established for each curve. Numerous figures are tabulated showing an average difference of less than 0.05% between the results of spectroscopic and chemical analyses. Details as to electrodes, spark circuit, procedure, etc., are given. Details of spectrographic practice in a German plant making Al alloys are presented by H. MORITZ ("Ueber einige Erfahrungen bei quantitativen Spektralanalysen von Aluminium und Aluminiumlegierungen," *Aluminium*, Vol. 21, Apr. 1939, pp. 301-306), who gives much attention to the method of casting the sample and to the photographic technique.

The increasing importance of spectrographic analysis as an industrial control tool is attested by the appearance of a new journal devoted exclusively to spectrography, and containing articles in various languages. Its first issue contains, among other things, a highly useful statistical examination of 2 photometric methods (the variant and the constant exposure) as applied to about 1,000 determinations made on various Al and Mg alloys (I. A. MCCLELLAND & H. KENNETH WHALLEY, "The Quantitative Spectrographic Analysis of Solder Magnesium and Aluminum Alloys," *Spectrochimica Acta*, Vol. 1, May 24, 1939, pp. 21-30). Evaluation is based on speed, applicability, reproducibility and accuracy of the methods. Procedural factors such as choice of standards, the pre-sparking effect and electrode size receive consideration. X (H-8)

The Testing of Sheet Metal Destined for Deep Drawing and Pressing. J. D. JEVONS. *Sheet Metal Ind.*, Vol. 13, June 1939, pp. 775-780; July 1939, pp. 901-906. Excellent comprehensive review. Chemical analysis is not very useful as a "test" for material to be deep drawn, because of the time required, because only average figures are obtained, and because the form of impurities is more important than their amount. Microscopic examination is often helpful, provided the angle of microsection relative to sheet surface and the distance between the section and the surface are given. The microscope is often the only means of revealing the cause of failure; it can determine nature, distribution, and approximate amount of inclusions, segregations, second phases, grain size, and regularity of grain size, all of which have important effects on drawing properties. Hardness test values give no indication of true deep drawing properties and are useful only for rough acceptance test. Bend tests, which include many types from crude shop tests to elaborate machine tests, have an advantage in their ability to detect severe internal discontinuities in material of outwardly satisfactory appearance. The Tour-Marshall machine is mentioned, in which the specimen is bent and a stress-strain curve is obtained as in the usual tensile test. The yield point elongation is supposed to give a useful indication of the tendency toward stretcher strains.

Somewhat closer to the cupping tests is the slotted-strip test of Siebel and Pomp. Two parallel slots are cut near the center of a sheet sample and the slotted part is pressed into a loop by a 20 mm. diam. roller. The fracture of the loop is taken as the end point, and the depth of the depression and elongation after the loop is flattened are measured. This test is intermediate between tensile and Ericksen tests, but it does not simulate commercial pressing conditions as closely as does the Ericksen. The "tear-length" test is often very useful. In it, 2 parallel slots are cut 1 cm. apart in the edge of the specimen; the resulting flap is gripped with pliers and pulled so that a triangular flap is detached. The height of the triangle in cm. is the tear-length value. This test is simple, but gives valuable information on directional effects and "tenacity."

Possibly the best known of the cupping tests is the Ericksen test. In making it, not only the depth of the cup, but the appearance of the surface of the dome should be recorded, as the latter is closely related to the average grain size. The appearance of the fracture gives an indication of the presence of directional properties. Consistent results by different operators are difficult to obtain because of differences in the tightness of clamp-

ing and amount of lubricant. Specimens smaller than the standard 3½ in. sq. should not be used, as the cup depth is considerably greater on smaller sizes. The thickness of the sheet has a marked effect on the results, and should always be specified; the thinner the sheet, the less reliable the test. This test is the most widely used cupping test and does detect unsatisfactory sheet, although it does not provide complete information on the deep drawing properties. Olsen and Amsler cupping tests are similar in principle to the Ericksen. The Guillery cupping test is also similar to the Ericksen, but the punch is loaded by oil pressure rather than by transmission of the pressure directly from the screwed spindle to the punch. In the Jovignot test the cup is formed not by a solid punch, but entirely by fluid pressure acting on one side of the specimen. Results are expressed as the cupping coefficient, or ratio of depth of cup at fracture to the applied pressure. A stress-strain curve may also be obtained by taking a series of readings of pressure and the height of the dome; this curve represents the behavior of the sheet in the weakest direction.

The National Physical Lab. has used a modification of this test with an automatic recorder. Errors due to friction are eliminated, the end point is more precise and the results are more consistent than the Ericksen; but the method of deformation is even more unlike commercial operations than in the Ericksen and similar tests. A. E. G. and Ericksen deep drawing tests are really deep drawing tests, but can be used as cupping tests. In the Kaiser-Wilhelm-Institut test, a machine similar to the Ericksen is used, but the punch has a flat bottom with a central projection which fits into a hole made in the middle of a square or round specimen. The end point is the appearance of radial cracks at the edge of the hole. The result is expressed as the per cent increase in the diameter of the hole at the end point. The hole must be carefully finished and a round specimen is preferable to a square; both factors increase the preparation time. The test is supposed to distinguish differences in deep drawing properties that are not shown in the Ericksen test, and also to give a better indication of directional properties. JZB (T-8)

Testing Sheet for Uniformity (Ueber die Prüfung von Blechen auf Gleichmässigkeit) E. MOHR. *Metallwirtschaft,* Vol. 18, May 12, 1939, pp. 405-407. Research. The author uses a bend tensile test to measure directional properties in sheet. In this bend tensile test the specimen is subjected to a static load while being bent back and forth a predetermined amount. Number of cycles to failure is recorded. A graph of static stress against number of cycles to failure reveals an inversion point, which is called the bend tensile strength. The bend tensile strength corresponds approximately with the alternating bend fatigue limit. The bend tensile test can be used for the rapid determination of sheet fatigue values. For testing the uniformity of sheet, a static stress below the 0.2% yield stress is chosen, and a number of cycles to failure (10°-20° bend) is recorded for various directions in the sheet. A plot of cycles to failure against direction reveals that this test is much more sensitive to anisotropy than the simple tensile test. Data are presented for Al-base, Zn-base and Mg-base sheet. The sensitivity of this test to variations in properties is attributed to variations in microstructures (elongated grains and secondary constituents) that are not effective in the tensile test. This method of testing is advanced as a rapid means for determining variation in sheet properties, thus being a valuable tool in any development of a rolling technique necessary for producing uniform sheet. [According to the data presented, this test will reveal sheet to be quite directional, though judging from the tensile test one would consider the sheet as uniform.—G. A.] GA (T-8)

Hardness Testing. V. E. LYSAGHT (Wilson Mechanical Instrument Co.) *Can. Metals Met. Inds.*, Vol. 2, June 1939, pp. 131-135. A review of the difficulties which users of hardness testing equipment encounter. Such difficulties are classed in 3 groups: (1) use of so-called conversion tables, (2) testing thin material, and (3) testing round material. The results of different methods are not directly comparable, and while conversion is a simple method of eliminating all but one hardness scale, it is not an ideal method. In fact, no ideal method is at present available. When conditions approaching those at limiting thickness are met, the two factors tending to modify the reading are normal flow to the axis of indentation (which tends to lower the readings), and the resistance and hardness of the anvil (which tends to give higher readings). In testing small rounds, the diameter of the part, as well as information as to whether the test was made on round or flat surface, should be recorded. The Knoop Indenter, developed at the National Bureau of Standards, permits the testing of very thin material and the making of tests on small areas. The hardness number is obtained by dividing the load applied by the surface area of impression which can be calculated from one dimension of the diagonal. The shape of this instrument permits making hardness tests on material such as glass, vitreous enamels, tooth enamel and certain gems which have been subject to cracking and spalling under former indentation tests. WHB (T-8)

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8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Practical Factors Affecting Fatigue Strength. Despite constant reiteration, the idea that fatigue test results on standard "perfect surface" specimens should *not* be applied to engineering design indiscriminately has difficulty in taking hold. The shape of the part, its working surface, compressive stresses previously applied to the unit, etc., very strongly affect the endurance properties of machine parts, so that the susceptibility of a given metal to such factors is often more useful an indication of fatigue properties than is its endurance limit as tested on polished samples of simple geometry. The automobile crankshaft, a most important engineering product, presents an excellent example of the care that should be taken in selecting material and designing for fatigue resistance. Of particular interest are torsion and bending fatigue tests made on several types of finished crankshafts, both forged and cast, by KURT BANDOW ("Dauerhaltbarkeit von Stahl- und Gusskurbelwellen" *Deutsche Kraftfahrtforschung,* No. 14, 1938, 35 pp.).

Among other things, Bandow's results show that actual fatigue properties are often veiled by aggravation of weakness through incorrect shaping of the part. Actual fatigue properties essentially are dependent on crank diameter and sharpness of section changes. The fatigue properties of forged steel crankshafts can be improved by cold working the crank transitions or by suitable hardening of the endangered zones; present experience indicates cold working to be more effective. In the most favorable case, the fatigue strength of the crankshaft attains the bending fatigue strength of the material itself, provided the notch effect of the transitions is opposed as much as possible by artificial introduction of an initial stress system through cold work. In torsion fatigue tests, 60% increase of the fatigue properties could thus be effected. Crankshafts of pearlitic cast iron and blackheart malleable cast iron possess relatively favorable fatigue properties, because of their lower notch-sensitivity. The application of cast metals to crankshaft production offers the paramount advantage that even the most intricate shapes can be processed without great difficulties. At present the Ford "half-steel" seems to be the most suitable material. Several types of crankshafts were improved by modifying the shape after making very precise dimension measurements and endurance tests on cast models. Cast crankshafts of Ford material with the modified cheek shape gave torsion and bending fatigue properties superior to those of forged steel crankshafts not cold worked. All in all, the author definitely proved that cold working and suitable shaping bring about a considerable increase of the fatigue properties of common types of crankshafts.

Great though the fatigue problems of crankshafts may be, they are not so exasperating as those of certain other automotive parts, such as connecting rods, shackles, etc. Yet the same factors—suitable shaping and favorable pre-stressing—can be employed to improve their fatigue properties, according to A. THUM and E. BRUDER ("Gestaltung und Dauerhaltbarkeit von geschlossenen Stabköpfen und ähnlichen Bauteilen," *Deutsche Kraftfahrtforschung,* No. 20, 1938, 10 pp.). Using a 50-ton Losenhausen pulsator, tensile fatigue tests were made to determine the effect of shape on the fatigue properties of shackles; the extent of improvement afforded by introducing favorable initial compressive stresses within the bores, and, particularly, the effect of various degrees of bore-widening by cold work; and the effect of the bolt seat on the fatigue properties and the location of the fatigue fracture in shackles. The results show that suitable shaping and pre-stressing can increase the fatigue properties of closed connecting rods as much as 100%. GN (8a)

Reduction of Shock Pressure in Solvent Delivery Lines. HOWARD S. GARDNER & JOHN H. FOLWELL (Eastman Kodak Co.) *Ind. Eng. Chem.,* Vol. 31, Apr. 1939, pp. 446-451. Practical. The simple theory of development of shock pressure is outlined. Pressures in excess of 200 lbs./in.^{2}, and leaks in a welded 3-in. solvent delivery line one mile long were caused by rapid closure of valves at the delivery end of the line. Microscopic examination of the pipe structure at points of leakage showed transcrystalline cracks, typical of fatigue failure resulting from repeated impact stresses from shock pressure waves. The failure may have been accelerated in the presence of solvents causing corrosion fatigue. Slow-closing valves were used to reduce the shock pressure. Two years of service are evidence of the adequacy of the protective measure. MEH (8a)

Testing Methods and Apparatus for Crank Shafts of High-speed Combustion Engines (Versuchsmethoden und Versuchseinrichtungen für Kurbelwellen Schnellaufender Verbrennungsmaschinen) CORNELIUS. *Automobiltech. Z.,* Vol. 42, Apr. 10, 1939, pp. 190-197. Practical. It is impossible to determine the true stress distribution in a crank shaft stressed in torsion, but fatigue tests are made and are widely used for general appraisal. The fatigue strength depends upon the shape of a part more than on its material, so that by special design much more can be achieved than by application of high-alloy steels. For testing the influence of material and shape on the fatigue strength, it may be simpler and more economical to test single or double cranks than complete shafts. The one end of the crank is clamped solidly, the other one is connected with an oscillator with variable momentum of inertia supported in 2 roller bearings so that no bending oscillations can occur. The amplitude is measured by the width of a light beam. The machine is run on the rising branch of the resonance curve where the slope is not too steep to permit a very slight variation in speed. An early stage of a crack is registered by the increase of the amplitude at that moment because the system moves up on the steep branch of the resonance curve. Automatic cut-off or alarm systems can be actuated this way. When determining a Woehler curve, the amplitude is set to such an amount that fracture occurs at 2 to 3 x 10^6 cycles. For subsequent tests, the amplitude is reduced by certain steps until one runs for 10 x 10^6 stress reversals without failure. The testing of complete crank shafts, using somewhat similar equipment, is described. The cranks carry additional variable weights, and the crank shafts break regularly in the last crank. In order to superimpose a stationary stress, a weight is attached to the end of the oscillator whose momentum is absorbed by a soft spring at the free end of the shaft. The determination of the critical torsion frequency and elastic properties is described. Bending fatigue tests are carried out by connecting a mechanical oscillator to the center cranks. Only a sinus-like horizontal force acts, the vertical component of the centrifugal force being absorbed by the bearing. The amplitude is measured by the width of a light beam. The dynamic elastic deflection line may be determined by using several light sources. The procedure is identical with that of the torsion tests. RPS (8a)

Static and Fatigue Strength of Welded Reinforcing Bars. BUHLER. *Welding J., N. Y.,* Vol. 18, Feb. 1939, Suppl. pp. 49-51; abstracted from *Beton u. Eisen,* Vol. 37, Aug. 20, 1938, pp. 258-263. Research. In Europe the longest concrete reinforcing bars appear to have been those used in the Dreirosen Bridge at Basel, which were 130 feet long. The usual length of the bars in German highway bridges is 98 feet. Longer bars are obtained by welding or by the use of sleeves. Fatigue stresses are not usually considered in reinforced concrete design. Nevertheless, in railway bridge design the fatigue limit of reinforcing bars and joints is often involved so that the same design procedure is necessary as for steel structures. Static and fatigue tests were made on a low-alloy steel containing 0.25-0.30 C, 0.6-0.8 Mn, less than 0.35 Si, 0.4-0.5 Cr, less than 0.035 P, and less than 0.035 S. The well known effect of mill scale in reducing the fatigue limit of unwelded steel was confirmed. The pulsating tension fatigue strength of the joints was 20,000 lbs./in.^{2} at 5 million cycles as against 41,200 to 44,200 lbs./in.^{2} for unwelded bars. The results show that joints in reinforcing bar are entirely satisfactory where fatigue is a minor factor. If fatigue is important joints of any sort should be used with caution, long unwelded bars being preferable to several short lengths screwed or welded together. CEJ (8a)

The Question of Fatigue Fracture: Magnet Powder Picture and Cracks Leading to Fatigue Fracture (Zur Frage des Dauerbruches: Magnetpulverbild und Dauerbruchanriss) M. HEMPEL. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch., Düsseldorf,* Vol. 21, No. 9, 1939, pp. 147-162. Research. Fatigue fracture can occur in machine and structural parts if alternating stresses exceeding a definite load value are imposed for a certain period of time. The fractures are characterized by their ordinarily fine-grained appearance and the often arc-shaped margin of the fractured area, while the area of the remaining section is usually coarse-grained. The formation of a crack leading to fatigue fracture is favored by concentration of stresses at changes of section or if the structure changes under too high stresses. Literature explaining this phenomenon is reviewed and new experiments are described to elucidate how the initial cracks progress and in which manner the progress is influenced by shape, load and material. The early stage of development of a crack can best be detected by the application of magnetic powder; numerous pictures illustrate the progress under the various conditions. The evaluation of these pictures indicates that, for the same stress, the development of a fatigue fracture is particularly influenced by the shape of the piece, and that load and material is of lesser importance. The fatigue crack can be detected in solid rods after about 85-90%, and in hollow rods after about 30-60%, of the number of cycles leading to fracture have been applied. Ha (8a)

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9 Metallography

Structure and Constitution. Metallographic Equipment.

J. S. MARSH and C. S. BARRETT,
SECTION EDITORS

Recent Applications of X-ray Spectrography to Some Metallurgical problems (Applications Récentes de la Spectrographie des Rayons X à quelques Problèmes Métallurgiques) A. MICHEL. *Chimie et Industrie* Vol. 41, Apr. 1939, pp. 627-637. Review plus original research. The Debye-Scherer method lacks accuracy in its ordinary form for some metallurgical problems. According to a new method the rays of a standard body are superimposed on those rays of the specimen that correspond to diffraction angles between 75° and 90°; their relative position is determined very accurately. The simultaneous use of extreme rays and the constant presence of the standard furnishes high sensitivity and precision. The principle of the method, apparatus used, operation, and parameter calculation are described. Results obtained by applying this technique to 2 problems are reported. RPS (9)

9a. Ferrous

Some Important Iron Alloy Systems. Recently there have appeared several reports of investigations on various important systems of Fe with other elements, such as Fe-Co, Fe-Cu-Al, Fe-Zn and Fe-Cr-Mn, and several alloy steels. J. W. RODGERS and W. R. MADDOCKS ("The Influence of the Alloying Element on the A_3 Point in Iron-cobalt and Other Alloys," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst., Special Rept.* No. 24, 1939, pp. 167-177) found, contrary to expectation, a slight initial increase in the lattice parameters of Fe-Co alloys. A. J. BRADLEY and H. J. GOLDSCHMIDT, as part of a general investigation of the Fe-Cu-Ni-Al system, report on 2 types of Fe-Cu-Al alloys ("An X-ray Study of Slowly Cooled Iron-copper-aluminum Alloys. Part I—Alloys Rich in Iron and Copper," *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 833, 13 pp.; and "Part II—Alloys Rich in Aluminum," *Ibid,* Adv. Copy No. 835, 16 pp.). The Fe-Cu-Al system includes a comparatively simple portion at the Fe-Cu end, and a very complicated part near the Al end. The delineation of the boundaries between the 2- and 3-phase fields would be impossible by any other method than X-ray powder technique. As an example of the complexity of the system, it may be mentioned that the phase that includes the composition $FeCu_2Al_7$ may occur in equilibrium with any one of 6 other phases. The Fe-Zn system, important to galvanizers, is further investigated by F. HALLA, R. WEIL and F. GÖTZL ("Ueber das System Eisen-Zink, II," *Z. Metallkunde,* Vol. 31, Apr. 1939, pp. 112-113), who determined the structure of monoclinic ζ crystals isolated from a zinc pot. Continuing their attention to the brittle σ phase in alloys containing Fe and Cr, P. SCHAFMEISTER and R. ERGANG ("Die spröde Sigma-Phase im Dreistoffsystem Eisen-Chrom-Mangan," *Arch. Eisenhüttenw.,* Vol. 12, Apr. 1939, pp. 507-510) confirm the existence of this brittle, hard, non-magnetic phase in the Fe-Cr-Mn system with up to 50% Mn and 90% Cr. Finally, a very comprehensive study of the metallography of 21 different steels is reported by C. H. M. JENKINS, E. H. BUCKNALL and G. C. H. JENKINS ("The Thermal Analysis of Twenty-one Steels, and the Metallurgical Examination of Five Selected Steels," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.* No. 24, 1939, pp. 181-214). Heating and cooling curves of 21 steels are given, and certain steels are given special attention. These include a Ni-Cr steel, a Ni-Cr-Mo steel, a 13% Mn steel and a high speed steel. X (9a)

Nickel-iron Alloys. Information on the metallography and constitution of the Ni-Fe alloys is ever welcome because of the great industrial importance of so many alloys within this general system. C. A. BRISTOW ("The Constitutional Diagram of the Alloys of Iron and Nickel. Part I—The Delta Region," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.* No. 24, 1939, pp. 1-8) has investigated the Fe-Ni diagram in the region 1550°-1350° C., and up to 15% Ni. A. J. BRADLEY ("Structure of Meteorites," *Nature,* Vol. 143, Mar. 25, 1939, p. 518) has redrawn the Fe-Ni diagram on the basis of X-ray data after long heat treatments (details not given). Based on this diagram, the Widmanstätten structure is explained as a mixture of large α and γ crystals corresponding to α and γ equilibrium in the temperature range 350°-580° C. They cooled at a rate faster than 1° per day, and thus avoided a transformation $\alpha + \gamma \rightarrow \alpha + \alpha_1$ at 350° C. The coarseness of the structure is attributed to repeated heat treating cycles while the meteorite follows a cometary orbit that approaches near the sun. The theory is largely in accord with that of E. A. OWEN and R. W. WILLIAMS (*Nature,* Vol. 142, 1938, p. 999), and with a criticism of this by S. W. J. SMITH and J. YOUNG (*Nature,* Vol. 142, 1938, p. 1162).

Evidence for a superlattice in alloys of the permalloy type was sought by P. LEECH and C. SYKES ("The Evidence for a Superlattice in the Nickel-iron Alloy Ni_3Fe," *Phil. Mag.,* Vol. 27, June 1939, pp. 742-753). In order to obtain high permeability in such alloys, it is necessary in practice to use cooling rates of 1° C./min. or more through the temperature range 500°-400° C. The binary alloy Ni_3Fe (approximately the permalloy composition of 76% Ni, 24% Fe) does not become entirely ordered through this treatment. X (9a)

9b. Non-Ferrous

Some Non-ferrous Alloy Systems. Ag-Cd, Cd-Sn-Tl, Au-Ga and Ni-Sb alloys are the respective subjects of 4 recently published papers on constitution. E. A. OWEN, J. ROGERS and J. C. GUTHRIE ("An X-ray Study of Silver-cadmium Alloys," *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 837, 16 pp.) after an X-ray examination of the Ag-Cd alloys, construct a diagram somewhat different from that shown in the *International Critical Tables.* E. JÄNECKE ("Ueber das System Kadmium-Zinn-Thallium," *Z. Metallkunde,* Vol. 31, June 1939, pp. 170-171) established, by thermal analysis, the ternary Cd-Sn-Tl diagram. The ternary eutectic contains 19% Cd, 42% Sn and 39% Tl, and melts at 129.5° C. F. WEIBKE and E. HESSE ("Ueber die Legierungen des Galliums mit Gold," *Z. anorg. allgem. Chem.,* Vol. 240, Mar. 7, 1939, pp. 289-299) have studied the Au-Ga system, applying thermal analysis, microscopy and X-ray diffraction to 52 alloys. Ga dissolves in Au up to 26.1 atomic % Ga at 352° C., 15.8 atomic % Ga at 200° C., and about 10 atomic % Ga at room temperature. Two compounds exist—AuGa and $AuGa_2$ with maximum melting temperatures of 468° and 492° C., respectively. SHIBATA ("The Equilibrium Diagram of the Ni-Sb System," *Nippon Kinzoku Gakukai-Si,* Vol. 3, June 1939, pp. 237-249; in Japanese) used practically everything but X-ray diffraction in his investigation of the Ni-Sb alloys. Two new phases were found: δ, whose basis is Ni_3Sb, is formed at 59.12% Ni and 698° C. by the peritectoid reaction $\alpha + \beta \rightleftarrows \delta$, and has a small solubility range; θ, whose basis is Ni_7Sb_2, is formed at 52.93% Ni and 588° C. by the peritectoid reaction $\beta + \gamma \rightleftarrows \theta$, and it also has a narrow solubility range. X (9b)

Some Ternary Systems of Aluminum. II. Aluminum-Iron-Manganese, Aluminum-Copper-Manganese (Über einige Dreistoffsysteme des Aluminiums. II. Aluminium-Eisen-Mangan, Aluminium-Kupfer-Mangan) HEINRICH HANEMANN & ANGELICA SCHRADER. *Z. Metallkunde,* Vol. 31, June 1939, pp. 183-185. Original research. In the Al corner of the Al-Fe-Mn system, a eutectic occurs at 1.8% Fe and 0.7% Mn, and 654° C.; it is built up by α-Al solid solution, Al_3Fe and Al_4Mn solid solution. The phase Al_4Mn has an extended homogeneity range and dissolves varying amounts of Fe. No ternary phase exists in the Al corner of the diagram. The alloys with higher Mn concentrations show peritectic structure, with Al_4Mn and an unknown phase "X" present. In the Al-Cu-Mn system a ternary eutectic consisting of α-Al solid solution, Al_2Cu and a rhombic phase T occurs close to the Al-Cu side of the diagram at 31.5% Cu and 0.8% Mn. By means of microscopic tests the phase distribution at 500° C., was established. There are 3 peritectic changes. EF (9b)

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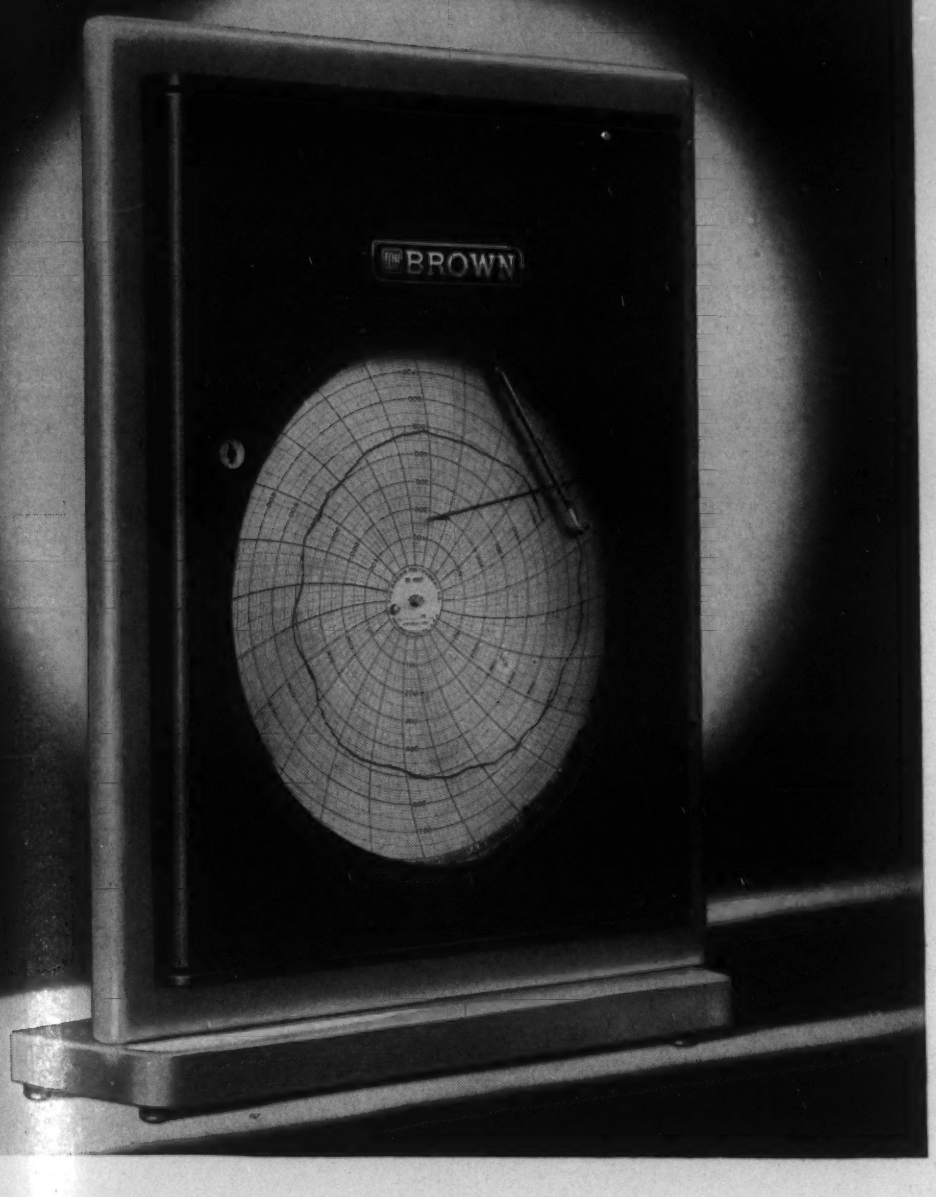

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10 Properties and Applications

Including Relation of Properties to Engineering or Product Design. See also Section 8a and 11.

M. GENSAMER, A. J. PHILLIPS and H. C. CROSS, SECTION EDITORS

Materials for Worm Gear Drives. C. H. BIERBAUM. *Machinery, N. Y.*, Vol. 45, June 1939, pp. 692-697. Practical. Between gear and worm there is essentially sliding contact. Early electrical machinery that had given excellent service for over 50 years was examined; bearings had a "true run-in bearing surface" with hard bearing crystals in relief by 3 to 6 microns and a depressed matrix, while journal was of a homogeneous cold-rolled low-carbon steel. Modern worm wheels are Cu-Sn alloy to which Ni may be added to increase the hardness, or Pb if the worm is soft steel. In extreme cases, Al bronze may be used. Now the worms are frequently carburized low-carbon steel, although many manufacturers have gone to heat-treated higher-C S.A.E. steels, nitrided cases, or flame or induction hardening, because carburized worms have given much trouble in service due to warpage and uneven cases after grinding. Both gear and worm should be free from hard abrasive particles caused by over or under-deoxidation (i.e. SnO_2, Zr nitride, etc.). There is now such a wide difference in hardness that worm and gear will not polish each other in service, and both must be carefully polished prior to installation. JZB (10)

Wires for Electrical Applications. The electrical manufacturing and distribution industries together consume a very large proportion of our metal products, and the metallurgical problems of these industries are correspondingly numerous. Wire for heating elements, for cold resistance units, for lighting and radio tube filaments, and for photo flash light may represent only a relatively small fraction of all the metal products of electrical interest, but they also represent some of the greatest problems.

Although the quality of modern nickel-chromium resistance alloys for electric heating elements is, on a service-life basis, many times greater than in years past, attempts to improve them further proceed apace. Thus, A. L. SANFORD and O. E. HARDER ("The Effects of Substantial Additions of Aluminum, Cobalt, Titanium and Columbium on the Properties of 80 Nickel-20 Chromium Alloys," *Trans. Am. Soc. Metals*, Vol. 27, June 1939, pp. 538-569) sought improvement by adding 2.5, 5 and 10% each of Al, Co, Ti or Cb. A commercial 80 Ni-20 Cr alloy was used as the base for comparison. The Al additions of 2.5 and 5% were the most beneficial, resulting in increased tensile properties up to 1450° F. (except elongation, which dropped badly between 1100° and 1450° F.), increased hot hardness, increased electrical resistance and increased life (to burnout) at 2150° and 2300° F. A Cb addition of 10% gave increased electrical resistance and better tensile properties and hardness up to 1850° F. The lower Cb and the Ti additions were less beneficial. Co additions seemed to be without advantage in the case of the properties studied. The experimental alloys (except 2.5% Ti) showed growths of 0.001-0.009 in./ft. on heating 100 hrs. at 1900° F., but retained their cold bending properties after heating at 2400° F. for short periods.

The electrical industries are largely concerned with the high temperature life of such alloys, and are interested in the other properties only insofar as they affect that life or as they provide ready media for acceptance tests. From this standpoint, therefore, the most significant result of these tests is the improvement in total life achieved by adding 2.5% and 5% Al. E. FETZ, however, in discussion, pointed out that for many purposes the "useful life" is considered to be the life to 10% increase in resistance in a constant-voltage test, rather than the life-to-burnout in a constant temperature test, as employed by the authors. Using the same material, submitted by the authors, Fetz repeated the life tests according to the standard A.S.T.M. test, which is a constant voltage, life to 10%-resistance-increase and also life-to-burnout test. He found, as they did, that Al tended to increase the life-to-burnout, but that the unmodified 80-20 Ni-Cr alloy was best on a life to 10%-resistance-increase basis. His company's practical experience with Al additions had been that maximum benefit is conferred by ¾% of that element; above 1% life to 10%-resistance-increase drops although life to burnout continues to improve. [The constant voltage test, during which the temperature of the wire may drop gradually because of progressive resistance increase throughout the test, is generally preferred for *service* tests because it simulates actual house-line operating conditions, which are always constant voltage. For scientific comparisons of high temperature behavior, the constant temperature test is undoubtedly more accurate, but the results may play one false if he selects electrical heating element material for domestic service on such a basis.—F.P.P.] Fetz also pointed out the very powerful effects of other elements not considered by the authors, yet undoubtedly present in widely varying amounts in their alloys, such as Si and Ca.

Also of interest to users and makers of resistance alloys, who often have to test operating temperatures optically, are spectral emissivity data published by W. F. ROESER ("Spectral Emissivity (at 0.65 Mu) of Some Alloys for Electrical Heating Elements," *Am. Soc. Testing Materials*, Preprint, June 1939, 8 pp.). Four commercial alloys—80 Ni, 20 Cr; 60 Ni, 16 Cr, 24 Fe; 37.5 Cr, 7.5 Al, 55 Fe; and 23 Cr, 5 Al, 2 Co, 70 Fe—were tested. The emissivity of the oxide formed on each general class of material in air was apparently definite and characteristic of that class of material. In the absence of oxygen (hydrogen atmosphere), the emissivities of all alloys tested were about 0.35. Also of use may be data presented in an article by J. FISCHER ("Untersuchungen an vom elektrischen Strom erwärmten Drähten," *Z. tech. Physik*, Vol. 20, May 1939, pp. 140-148) elaborating on the author's previously described method of calculating the temperature rise in wires heated by an electric current. Precision measurements of the elongation and the increase of electric resistance of round wires of various diameters and lengths, as depending on the amperage, voltage or wattage of an electric current passing through them, were made on Cu, Ni, manganin and a Pt-Ag alloy.

Alloys of the manganin type, useful for cold resistance elements in precision instruments are somewhat unstable, and require careful control of manufacturing operations and even storage conditions if the desired properties are to be obtained and maintained. The properties of "Novokonstant," a Ni-free Cu-Mn-Al-Fe alloy with electrical properties similar to those of manganin but with greater stability, are described by A. SCHULZE ("Untersuchungen an dem Widerstandswerkstoff Novokonstant," *Physik. Z.*, Vol. 40, May 15, 1939, pp. 357-361). The alloy contains 82.5% Cu, 12% Mn, 4% Al and 1.5% Fe. The resistance-temperature curve follows closely that of manganin at —200° to +300° C., and passes a minimum at 150° C. The course and maximum of the resistance-temperature curves depend greatly on the thermal pretreatment, and are given for annealing temperatures of 125°, 250°, 400° and 540° C. The alloy has a favorably low thermal e.m.f. against Cu, 0.3 microvolt/° C., and its electrical resistance is 270 ohms/e.m.f. Best temperature vs. resistance properties are obtained with wire annealed for several hrs. at 400° C. [Alloys very similar to this were described a few years ago by J. L. THOMAS (see *Metals and Alloys*, Vol. 7, Nov. 1936, p. MA 545L/2), who found a base alloy containing 85% Cu, 9.5% Mn and 5.5% Al to be very amenable to control through proper baking and judicious additions of Fe to the alloy, and to be even more stable in its properties than "Novokonstant" is reported to be.—F.P.P.]

Some useful data on high temperature properties of Ta wire for electronic tube applications are given by L. MALTER and D. B. LANGMUIR ("Resistance, Emissivities and Melting Point of Tantalum", *Phys. Rev.*, Vol. 55, Apr. 15, 1939, pp. 743-747). The relation between true and brightness temperatures, the brightness temperature as a function of heating current, and the melting point were determined. The value found for the last was 3269° K. Also of interest to those using and making radio tube alloys is the recently proposed method of testing Ni alloy filament wire ("Testing Nickel and Nickel Alloy Wire and Ribbon for Electronic Tube Filaments", Report of Committee B-4, *Am. Soc. Testing Materials*, Preprint No. 17, June 1939, 23 pp.), which provides for tensile strength, weight, electrical resistivity and dimension tests.

Interesting information on metals and alloys suitable for photo flash bulb elements is presented by I. A. M. VAN LIEMPT and J. A. DE VRIEND ("Studien über das Verbrennungslicht einiger Metalle und Legierungen, II," *Rec. Trav. Chim.*, Vol. 58, Apr.

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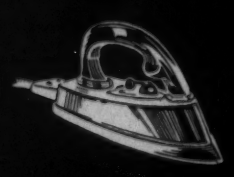

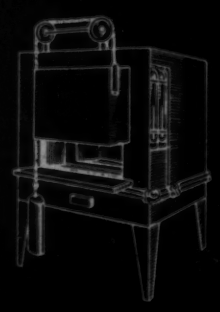

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1939, pp. 423-432). Previous investigations (see also *Metals and Alloys*, Vol. 8, Oct. 1937, p. MA 637 L/9) were extended to Th and Ti and to several Al alloys to study the effect of various additions to Al. Tests on Al-Zr alloys showed that the flash-time is much longer than for Mg, and the light yield for 1 g. of alloy is 810 lm.-sec. Among the Al-Mg alloys, "Magnalium" with 7-9% Mg is of established importance as flash bulb material. Addition of 2% Zr was without advantage; strength and brittleness of the wires increased with the Zr additions. 2.5% Ti was alloyed to Al without raising the strength materially; the flash-time was 0.046-0.06 sec. and the light quantity per mg. 933 lm.-sec. An Al alloy with 1% Ca yielded stronger wire, which flashed in 0.065 sec. and set free 770 lm.-sec. A critical discussion on the testing of the suitability of metals and alloys for flash bulb purposes is appended. X (10)

10a. Ferrous

The Properties of Alloy Steels. General discussions of alloy steels as a class are often subject to a certain ambiguity because of the still unanswered question as to what constitutes an "alloy steel." Just where does a minor constituent cease to be an "impurity" and become an "alloying agent"? Because this amount differs with the various constituents, no simple general definition of an alloy steel is possible, but it should be possible to agree on such matters as how much of each constituent constitutes an "alloying" amount. A. PORTEVIN ("La Qualité de l'Acier et les Aciers de Qualité," *Rev. Universelle Mines*, Vol. 15, June 1939, pp. 320-337) sets forth in interesting fashion his ideas on this subject. He proposes to classify as alloy steels those containing more than 1% Mn or Si, more than ½% Ni or W, more than ¼% Cr, Cu, Mo or Al, more than ⅛% V and more than 0.1% S and P. As criteria for quality, characteristic values as quantitatively determined in the ordinary tests, or in tests of more complex properties such as machinability, deformability, wear resistance, appearance and physical defects, could be employed.

Determination of several specific physical property values for a series of 8 carbon, 8 alloy and 6 high-alloy steels has been made by J. H. AWBERRY ET AL ("The Physical Properties of a Series of Steels.—I," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.* No. 24, 1939, pp. 215-251). Specific heats and total heats up to 900° C. were measured for the first group, together with thermal conductivities and electric resistivities of all except a eutectoid steel up to about 300° C., and the coefficient of expansion to at least 1000° C. for the 7 carbon steels other than the eutectoid steel. In general, the coefficients of expansion are greater for the low-C steels at low temperatures, become roughly independent of the C content when measured over the range 0-600° C., and finally reverse so that the steel of highest C content has the greatest coefficient of expansion over the range 0-1000° C. The thermal conductivity is greatest for the purest Fe, and in this case shows a fall with increasing temperature. As the proportion of alloying constituents increases, the conductivity decreases and its rate of change with temperature becomes smaller, so that the high-alloy steels show an increase of conductivity with increasing temperature. The electrical resistivity always increases with temperature, and in general increases with the complexity of the steel.

Three articles on the effects of specific alloying or addition agents on the properties of steels have recently appeared. WALTER CRAFTS ("Chromium in Structural Steel," *Metals Tech.*, Vol. 6, June 1939, T. P. No. 1055, 13 pp.) studied the influence of up to 2% Cr on the mechanical properties of low alloy steels, by preparing small heats, working to 1-in. rounds, normalizing and determining tensile properties and impact resistance. Steels having tensile strengths of 60,000, 75,000 and 90,000 lbs./in.^{2} were considered. Chromium had but little effect on yield point. In some of the steels it increased tensile strength, and in many steels it increased impact resistance. A comprehensive review of published material on the effect of Ti on steel and iron is presented by L. NORTHCOTT ("Titanium and Its Effect upon Iron and Steel. I—A Summary of Published Information," Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.* No. 24, 1939, pp. 107-146) with 121 references included.

The third article of this type, by E. HOUDREMONT and H. SCHRADER ("Die Wirkung von Molybdän im Kohlenstoffstahl im Vergleich zu anderen karbidbildenden Elementen," *Tech. Mitt. Krupp*, Vol. 2, Mar. 1939, pp. 23-46), compares the character and effect of the molybdenum carbide as formed in steel, with V, Ta, Ti, Cb and Zr carbides. The addition of Mo increases the depth of hardening but delays the transformation; these effects are more pronounced the higher the C content. The increase of depth-hardening is much greater than the similar action of Cr in eutectoid tool steels, indicating a formation of mixed and easily soluble carbides. Diffusion phenomena in Mo steels are quite different from those in other steels. A stronger surface decarburization

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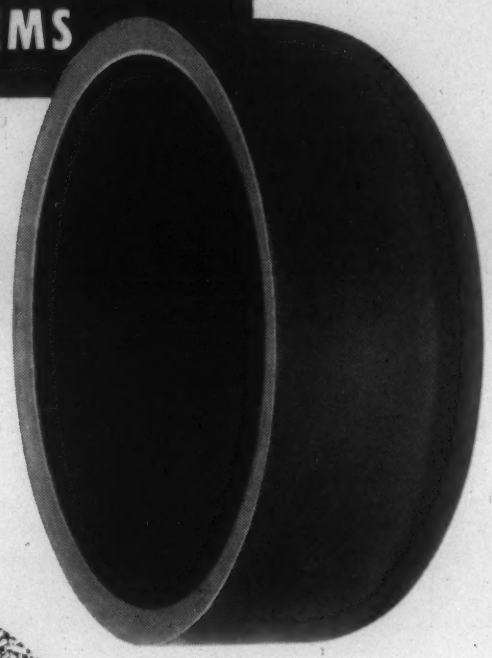

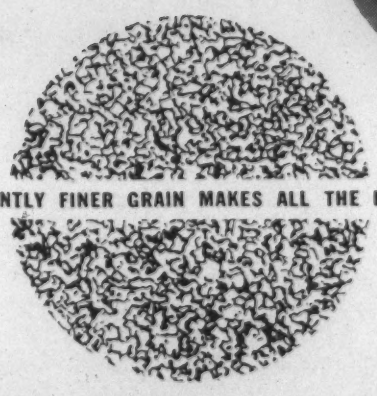

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seems to point to increased permeability for oxidizing gases, while C diffusion is not materially changed, as shown by approximately the same width of the hypoeutectoid zone. Mo steels show a tendency to irregularities in annealing, with fine-grain areas found, as well as carbide agglomerations. Mo must be considered as a special carbide-forming element, which accounts for the greater heat resistance and creep strength of Mo steels. The effect of Mo on the properties of steel is somewhat similar to that of Cr.
X (10a)

Improvements in the Construction and Metals of Pressure Vessels. T. M. JASPER (A. O. Smith Corporation) *Ind. & Welding,* Vol. 12, May 1939, pp. 12-14, 48. Practical discussion. Today's industry requires large vessels capable of operating at a wider range of pressures than ever before; vessels to resist higher as well as lower temperatures than ever attempted; vessels resistant to corrosive attacks of many types and varying severity; vessels that will not discolor or contaminate the processing material. Safety in the operation of vessels at high temperatures and pressures is increased by using steels of greater strength, thus permitting the employment of thinner walls. Thicker vessels are likely to give trouble earlier than the thinner ones. In the construction of such vessels it is advisable to use steels that allow the thinnest walls consistent with sound design. Proper welded design permits the use of thinner walls than other forms of design and the lesser thickness increases the safety of operation in severe service. By adding 0.5% Mo to a carbon steel the long-time strength at 900° F. is increased over 100%. Extensive tests made on full size vessels as far back as 1930 led to a new design for small diameter, thick walled vessels. The heavy wall was built up of a multiplicity of layers instead of using solid plates or forgings. Each layer is a comparatively thin plate, which can be individually inspected for defects, and which is wrapped tightly around the preceding layer by a special machine. The innermost layer may be made of a suitable corrosion resistant steel.
CEJ (10a)

10b. Non-Ferrous

Heavy-duty Contacts. L. B. HUNT. *Electrical Rev.,* Vol. 124, Mar. 31, 1939, pp. 459-460. Practical. Electrical contacts for severe service must carry heavy currents for long periods without excessive heating or any physical changes, and withstand erosion and sticking due to arcing, as well as mechanical wear. Of the principal contact metals used, Cu and Ag have high electrical and thermal conductivities and low, contact resistances; W and Mo have high hardness and high melting point, resulting in much greater resistance to wear and arcing, but much lower conductivities. By the development of the method of high-temperature treatment of metal powders, it is possible to prepare combinations of a softer, higher conductivity metal with a hard refractory metal. The desirable properties of each are retained to a large extent. Individual particles of each are very finely divided and evenly distributed, so that effect of a true alloy is closely approached. This has been applied to production of a range of special contact materials designated "Elkonites." There are 2 grades, one consisting basically of Cu combined with either W, Mo, or their carbides, while the other comprises Ag with one or more of these refractory metals. Cu alloys are used primarily for operation in oil circuit-breakers and Ag alloys for operation in air. All grades are normally used as facing material only, being attached to a Cu or Cu-alloy backing by Ag brazing or mechanical union. Ag grades are used also in numerous applications as either Cu-backed or steel-backed rivets in relays and contactors, contact disks being brazed to backing in a high-temperature H_2 furnace. Alloy choice depends largely on the maximum current that may have to be handled.
MS (10b)

Light Alloys and Engineering Design. The weight-saving possibilities in the light-weight alloys and the high strength steels have been a tremendous boon to industry, but their expanding use has introduced a number of new problems for the designing engineer. A highly useful summary of design factors in the use of Al and Mg alloys, with particular reference to a comparison between such alloys, steel and cast iron has recently been published ("Bases of Design in Light Alloys," *Light Metals,* Vol. 2, July 1939, pp. 231-236). A complete mathematical treatment of the results of the simpler forms of stressing is given throughout, illustrated with many examples. Stressing in tension or compression, energy of deformation, thermal stress, bending stress and deflection, slender columns, and torsional strength are comprehensively discussed. Various cases are assumed, such as constant deflection, constant stress, constant stiffness, etc., and comparisons are made in cross section, and gain or loss in weight by substitution of Al for steel. Most of the facts are stated in formulas, so that the article becomes almost a short handbook on the subject.

A very good review of the practical factors involved in the application of wrought Al alloys to a specific field—aircraft—is given by J. H. MAYES ("Strain Hardened Alloys in Aircraft," *Sheet Metal Ind.,* Vol. 13, July 1939, pp. 910-912). Three classes of wrought Al alloys are used in airplanes: Low strength, good ductility alloys used for pressings and fairings; medium strength alloys; and high strength alloys. The first 2 classes are composed of strain hardened alloys, and the third class of heat treated alloys. Pure Al and Al with 1¼% Mn are suitable for intricate pressings. Higher air speeds necessitate the use of a stronger material for cowling than the Al; considerable use is being made of the 2% Mg/¼% Cr, and of the 5% Mg/½% Mn Al alloys. The corrosion resistance of the Al-Mg alloys is superior to that of the Al. In a semi-monocoque unit such as the fuselage, the tensile strength is secondary and the limiting buckling stress, which depends on the modulus and ratio of thickness to length, as primary. Therefore, strain hardened alloys in some cases are as safe as heat treated alloys, since all Al alloys have approximately the same modulus. Wider use is made of the strain hardened alloys in light civil aircraft than in large civil and military machines.

Design considerations in the application of light metals within still another field—shipbuilding—are discussed by W. C. DEVEREUX and E. V. TELFER ("Light Alloy Ship Construction" *Metal Ind., London,* Vol. 54, Apr. 28, 1939, pp. 471-474; May 5, 1939, pp. 485-487). Considerable amounts of Al-Mg alloys, usually cold-rolled, are used for internal ship work. In structural work, the particular design of sectional material is important. If the deflection of the light alloy beam is 3 times that of steel, the natural frequency of the light alloy will be about half that of steel. The strain energy of the light alloy is greater than steel, and the internal damping greater; the marked synchronism of steel structures should be absent in light alloys. Extreme streamlining in ship construction will be made possible only by light alloy structure. It is evident that even today the use of these naval Al alloys in warship and other fast craft is worthy of the closest examination as a competitor to steel, since if even the partial use of light alloy construction, at a price 9 times that of steel, can produce more economical design, the present price gap will be abridged without great difficulty.
X (10b)

Copper and Copper Alloys for Locomotive Firebox Construction. MAURICE COOK. *J. Inst. Locomotive Engrs.,* Vol. 28, 1938, pp. 609-642. Original research. Although steel is used for locomotive fireboxes in the U.S.A., Cu and Cu alloys are used in Europe. The mechanical properties in the range 20°-800° C. are presented for arsenical and non-arsenical Cu (both tough pitch and deoxidized with P), and a Cu alloy with 0.75% Ni and 0.5% Si (both annealed and temper-hardened at 450° C.). Results indicate that deoxidation with P has much greater effect in raising the temperature of recrystallization and improving ductility at high temperatures than additions of As. At room temperatures static mechanical properties of all the varieties of Cu are similar. Rotating beam fatigue strengths of tough pitch arsenical and non-arsenical, and deoxidized arsenical and non-arsenical Cu are, respectively, 6.3, 6.1, 5.8, 5.3 tons/in.^{2} for 10^8 cycles. Repeated deflection tests in which plastic deformation is produced indicate, on the other hand, that the deoxidized coppers are much more resistant to this type of reversed stressing than the tough pitch coppers. The temper-hardened Cu-Ni-Si alloy is very much superior in all respects to any of the coppers generally employed. Even at 350° C., its limit of proportionality is 10 tons/in.^{2}, it retains its ductility well, its rotating beam endurance limit is 9.5 tons/in^2, and it withstands reversed plastic deformation very much better than deoxidized Cu. Welding as a method of firebox construction and repair is discussed, and it is shown experimentally that grain growth, even when it occurs to a very much greater extent than arises near welded joints, is not likely to affect the serviceability of the material.
JCC (10b)

Effects of Aluminum and of Antimony on Certain Properties of Cast Red Brass. HAROLD B. GARDNER & CHARLES M. SAEGER, JR. *J. Research Natl. Bur. Standards,* Vol. 22, June 1939, pp. 707-727. Original research. Additions of Al in amounts from 0.005 to 0.10% were made to red brass made of remelted metal, of the nominal composition 85% Cu and 5% each of Sn, Zn, and Pb. Determinations of tensile properties, density, hardness, the running property, and the ability to withstand hydraulic pressure, made on various types of test bars and test specimens, showed that all additions of Al had a deleterious effect on the properties and the structure. The effect was more pronounced with the higher concentrations of Al and was particularly evident on the ductility and the resistance to hydraulic pressure. Additions of Sb to this alloy in the amounts ranging from 0.10 to 0.25% had only a nominal effect on all of the properties studied except the running property, which was increased. These results indicated that the presence of 0.25% of Sb is permissible, but that even 0.005% of Al has a deleterious effect on the alloy.
WAT (10b)

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10c. Effect of Temperature

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Recovery, Recrystallization and Creep Behavior of Some Cold Worked Austenitic Materials (Erholung, Rekristallisation und Kriechverhalten einiger kaltverformter austenitischer Werkstoffe) H. CORNELIUS. *Metallwirtschaft,* Vol. 18, May 12, 1939, pp. 399-403; May 19, 1939, pp. 419-421. Research. Recovery, recrystallization, and creep were studied on three austenitic materials of widely varying analyses. The alloys investigated were: (1) 17.6% Cr, 9.1% Ni, 0.16% C, 0.8% W, 0.1% Mo, 1.6% Ta and Cb, 69% Fe; (2) 27.4% Cr, 30.1% Ni, 0.45% C, 1.9% Ti and 39% Fe; and (3) 15.7% Cr, 40.0% Ni, 0.08% C, 1.5% Mn, 5.9% W and 16% Fe. Specimens were cold worked by stretching in a tensile machine. Recovery temperatures were measured by hardness changes, though in the cases of steels Nos. 2 and 3 precipitation phenomena made the determination difficult. Recovery starts for alloy No. 1 at 800° to 900° C. and is finished in 2 hrs. at 1000° C.; for alloy No. 2 at about 800° C. and is finished at 1100° C.; for alloy No. 3 recovery starts at 950° C. and is finished at 1100° C. Microscopic grain size determinations were used to determine recrystallization temperatures. The temperatures for complete recrystallization in 2 hrs. of the various alloys when stressed from 5 to 20% is 1000° C. for alloy No. 1, 1100° for alloy No. 2 and 1200° C. for alloy No. 3. Creep experiments were run below and above the temperature of the beginning of the recovery of hardness. It was found that below the temperature of the beginning of recovery, the cold worked material had the lowest creep rate while above that temperature the annealed material was superior. The creep specimens after testing were broken in a tensile machine and it was determined that the creep stressing did not alter the static properties of the materials investigated. GA (10c)

The Alloy Casting Research Institute Test Block for Heat-Resisting Alloys; Its History, Selection and Utilization. O. E. HARDER (Battelle Memorial Institute) *Am. Soc. Testing Materials,* Preprint, June 1939, 11 pp. Research to determine the most suitable type of test specimens for use with heat-resisting alloys in determining high-temperature tensile properties and creep characteristics. A previously developed wedge-shaped test block with a riser along the entire length but gated only at the bottom has been modified so as to introduce hot metal into the head or riser. Various kinds of test blocks, including end-headed round, A.S.T.M. B-4 block, keel block, star-gate, U-bar, side-head block and the block mentioned above are evaluated, with reference to ease of casting, soundness of specimens, mechanical properties of specimens, and the relative amount of metal to be melted to produce a given number of test specimens. The wedge-shaped block, which would produce four tension test specimens was adopted on the basis of these requirements. This paper describes its utilization in testing three types of heat-resisting alloys: NC-4 (35-15 Ni-Cr), CN-36 (25-12 Cr-Ni), and NC-2 (60-12 Ni-Cr). VVK (10c)

Fracture of Steels at Elevated Temperatures after Prolonged Loading. R. H. THIELEMANN & E. R. PARKER (Gen. Elec. Co.) *Metals Tech.,* Vol. 6, Apr. 1939, 18 pp. Original research. Equipment for sustained load rupture tests at elevated temperatures is briefly described. Results of tests on several steels at temperatures from 1000° to 1200° F. are given. The steels tested included 18-8 containing Cb, Cr-Mo, Cr-Mo-Si, C-Mo and ingot Fe. When oxidation did not play a part in failure, the log of stress plotted against log of time for fracture gave a straight line. Failed specimens were examined to determine whether failure was transcrystalline or intergranular. Higher temperatures and lower strain rates apparently favored intergranular cracking. The temperature at which intergranular cracking first occurs seems to be closely related to the recrystallization temperature of the steel, and, for tests of long duration, can be termed the equicohesive temperature. Intergranular failures do not occur when high rates of deformation are employed. The effect of oxidation is to shorten the fracture time. Transcrystalline fractures are accompanied by surface oxidation only. Intergranular fractures may or may not be accompanied by internal oxidation. The occurrence of intergranular oxidation is indicated by a change in slope of the log-log curve. Tests in H showed that intergranular fractures were not always caused by intergranular oxidation. JLG (10c)

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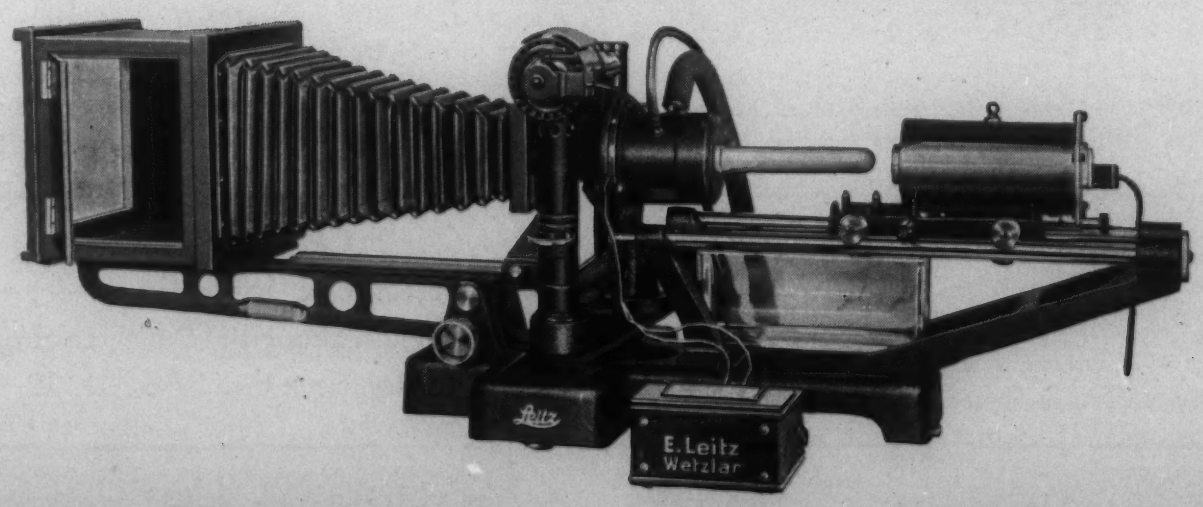

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11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Wear and Friction in Sliding Contacts, Especially between Carbon Brushes and Copper Rings (Ueber Verschleiss und Reibung in Schleifkontakten, besonders zwischen Kohlebürsten und Kupferringen) RAGNAR HOLM, H. PAUL FINK, FRIEDRICH GÜLDENPFENNIG & HERMANN KÖRNER. *Wiss. Veröffent., Siemens-Werken,* Vol. 17, Nov. 1938, pp. 73-100. Original research. Wear and friction in contacts between C brushes and rings or collectors, mainly of Cu, are measured in relation to different variables, especially pressure, circumferential speed, atmospheric moisture and electrical load. The experimental results can be easily reproduced and accurately expressed by formulas. Wear and friction depend greatly on foreign matter on the ring. Atmospheric conditions, (moisture, dust and O) and electrical currents directly influence these layers or films. The largest part of brush, ring and collector wear in actual service is caused by the evaporation of electrodes in the arc-like spark under the brush. If the number of the respective sparks, their life and their amperage are known, the corresponding cathodic evaporation can be calculated as the product of the quantity of electricity passing through the spark and a material-constant related to the metal and the atmosphere. It is assumed that the lubricants adhere variably well, according to whether the metallic surface is clean or oxidized. The O of the atmosphere may also have a certain harmful effect on the ground metallic surface, which becomes less dense (friction oxidation). Wear is thus decreased if O is excluded. Brush wear experiments on Fe rings did not furnish reproducible results. EF (11)

Preventing Oxidation and Tarnishing. G. J. THOMAS & L. PRICE (Univ. Cambridge) *Metal Ind., London,* Vol. 54, Feb. 10, 1939, pp. 189-190. Original research. The corrosion resistance offered by a film of high electrical resistivity such as alumina, beryllia and silica, is discussed. Two methods of obtaining such films on Ag and Cu were developed: Alloys containing small amounts of Al, Be or Si are heated in an atmosphere of H containing 0.1 mm. pressure of water vapor obtained by passing H through a 4% (wt.) solution of sulphuric acid or by cathodic treatment of Ag in a solution of Be salt at a pH of 5.8. Cu covered with a film of cuprous oxide oxidizes about 200,000 times as quickly as Cu covered with an equal film of alumina, and with beryllia the factor is even greater. Cu-Al alloy over ammonium sulphide tarnished in 30 min., but when selectively oxidized by heating at 500° C. for 20 min. in the H_2-H_2O vapor atmosphere, the same conditions did not produce tarnish. Tests also show that Cu-Be develops high tarnish resistance when treated by selective oxidation. The tarnishing of Cu can also be almost completely prevented by electrolytic deposition of a film of beryllia upon the surface. Electrolytic deposition of Be-Cu also prevents oxidation of Cu in air at elevated temperatures. These experiments indicate that the theories developed by the authors on the tarnishing of Ag appear to have wide application. The application of these methods to Cu may be of greater importance industrially than that to Ag, and the processes may be applicable to other metals, such as Fe. RWB (11)

12 General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

The Behavior of Noble Metals and their Copper-containing Alloys towards Oxygen in Liquid State and during Annealing in Solid State (Das Verhalten der Edelmetalle und ihrer kupferhaltigen Legierungen gegenüber Sauerstoff in flüssigem Zustande und beim Glühen in festem Zustande) E. RAUB & M. ENGEL. *Mitt. Forsch. Inst. Probieramts Edelmetalle,* June 1939, pp. 1-12. Unusually comprehensive review. Silver and the Pt metals absorb much O in molten state, which is given off again during solidification. These metals also show a strongly increased evaporation in O-containing atmosphere, owing to formation of intermediate volatile oxides that are gaseous at high temperatures, but disintegrate in cooling to form the metal and oxygen again. In neither the molten nor solid state, does Au absorb O noticeably. Copper is the most common alloying element in rare metals that readily combines with O. Silver melted together with CuO forms a eutectic on the Ag side of the equilibrium diagram, and a far-reaching miscibility gap in the liquid state in CuO-rich melts; these usually separate into 2 melts, the lighter one rich in CuO, and the heavier one rich in metal. Oxidizing melting powders should not be used in Ag alloys as they make the metal unfit for further working. When Au and CuO are melted together, a Au-Cu alloy is formed with violent evolution of O; in contradistinction to Ag, Au absorbs only very small amounts of CuO in the liquid state. Conditions are quite different, however, in the case of Au-Ag-Cu alloys; in general, with increasing content of Ag and Cu, Au alloys and CuO can exist in equilibrium side by side at higher temperatures (1300° C.). The behavior of Cu-bearing Pt metals towards O has not yet been investigated, but because of the high melting point, it can be assumed that CuO will not be formed very extensively on account of the very high O pressure of the CuO at these temperatures.

The oxidation velocity of Ag-Cu alloys in annealing increases very strongly with the Ag content—the commercially used alloys with 92.5 and 93.5% Ag scale faster than those with 83.5 and 80%. The oxidation velocity of the hypoeutectic alloys with about 71.5% is about the same as that of pure Cu. On the other hand, the Au-rich Au-Cu alloys show the least scaling, the oxidation velocity increasing with increasing Cu content. The Pd-Cu alloys reveal a rapid increase of oxidation velocity up to about 12% Cu, where a shallow maximum occurs; a decrease in velocity follows until at about 20-40% Cu a shallow minimum takes place and then again a steady increase until the value for pure Cu is reached. The oxidation velocity of Au-Ag-Cu alloys decreases if, with the same Au content, Cu is replaced by Ag. In Au-Pd-Cu alloys, the scaling velocity is decreased by Pd additions much more than by Ag, and alloys with high Pd content show only very little scaling. It was not determined to what extent the scaling velocity is influenced by formation of Pd oxide. An effect similar to that of Pd was observed in Ag-Pd-Cu alloys, where Pd also lowers the oxidation velocity of Cu, by retarding the O diffusion. Ha (12)

books

Anodic Oxidation of Aluminum

ELECTROLYTIC OXIDATION OF ALUMINUM AND ITS ALLOYS (Die elektrolytische Oxydation des Aluminiums und seiner Legierungen). *By A. Jenny. Published by Theodor Steinkopff Verlag, Dresden, 1938. Paper, 6 x 8½ in., 224 pages. Price 10.50 RM.*

This book is a welcome addition to the limited number of reference books dealing with the "anodizing" or anodic oxidation of aluminum. In addition to a general discussion of the subject it gives a good picture of current German practice. The book is divided into two parts, general and special, of nearly equal length.

The general part consists of an exposition of fundamental principles, such as the solution of salts in water, the behavior of metals immersed in a solution, the chemical behavior of metals against gases, the anodic reactions of a metal electrode, the chemical properties of aluminum and its alloys and the conditions which influence the anodic oxidation of aluminum.

The second part begins with a discussion of the characteristic properties of aluminum oxide films, particularly with relation to the nature of the material on which they are formed. This is followed by a discussion of the chemical reactions involved in the principal methods used. The term "Eloxal" (*El*ectrolytische *ox*ydierts *Al*uminium), orginally applied only to the method in which oxalic acid was used, is now applied generally to all methods. Detailed instructions are given for carrying out the various methods as well as for the supplementary processes for sealing the pores in the surface film, the coloring of the film, photographing on anodized surfaces, etc. Brief mention is also made of the simple immersion method used for producing surface films on aluminum without the application of an external e.m.f.

Although the book will appeal to only a relatively small number of readers, its value to workers in the particular field concerned cannot be questioned. A similar book in English would be very welcome.—H. S. RAWDON.

Bearing Metals

MATERIALS FOR BEARINGS (Werkstoffe für Gleitlager.) *By R. Kühnel. Published by Julius Springer Verlag, Berlin, 1939. Paper, 6½ x 9½ in., 427 pages. Price 48 RM.*

The author, in collaboration with 9 German experts, has prepared, in "Bearing Materials," an excellent book. The contributing authors represent all three groups: Producers, consumers and pure scientists. Such a distribution of the subject precludes one-sidedness and bias and makes this well-balanced book attractive reading, even for those not directly interested in bearing materials.

Individual chapters are devoted to aluminum- and magnesium-base alloys, (33 pp.); cadmium-base, (10 pp.); copper-base, (67 pp.); zinc-base alloys (12 pp.); babbitts (43 pp.); hardened lead-base alloys (38 pp.); and powder-metal bearings (14 pp.). A special chapter of 52 pp. pertains to non-metallic bearings, and three introductory chapters deal with general principles of bearing construction, fundamental viewpoints in selecting and evaluating bearing materials, and testing of bearings.

The value of the book is greatly enhanced by the use of many qualitative actual-service observations rather than by relying on individual testing data of apparent inadequacy. Although the standard babbitts are treated generously, a particular feature of the book is the obvious emphasis on the new *Ersatz* bearing alloys. This development is not entirely new, since frantic efforts were made during the war to employ lead-base, zinc-base and aluminum-base alloys as substitutes for babbitts, although most of these *Ersatz* alloys were discarded after the war. Recent years have seen a tremendous reawakening of German interest in these materials. For instance, an admirable account is given of aluminum and magnesium-base alloys for bearings. Most of the contributions have been made since 1936, and include some experiments in the German Aeronautical Research Institute that have not yet appeared or are just appearing in the technical literature.

The book, containing 324 illustrations and 63 tables, is quite up-to-date and fully considers non-German literature. Although the dynamic development in the field of bearing materials will necessitate early rewriting of entire chapters such as those on powder metal, light metal, non-metallic, zinc and cadmium-base bearings, etc., the present volume definitely fills an important gap in the international literature. The book follows the high Springer standard not only as to type, paper, illustrations, standing of authors, etc., but unfortunately, also as to price.

All in all, the book can be warmly recommended.—ERICH FETZ.

Metal Spraying

METAL SPRAYING. *By T. H. Turner & N. F. Budgen; revised by E. C. Rollason. Published by J. B. Lippincott Co., Philadelphia, 1939. Cloth, 6 x 9 in., 235 pages. Price $7.50.*

The first edition, published in 1926, by Turner and Budgen, has been revised and somewhat amplified by Rollason, of the University of Birmingham, this edition having some 60 pages and 30 figures more than the first. The additions include descriptions of a few more spray guns, notably one to use powder instead of wire, of precautions against health hazard from metal vapor, more detailed information on the necessity of roughening the surface of a metal base to secure adhesion of the coating, data on the virtue of filling the pores of the deposit with varnish, interesting information on improvement in resistance to wear and seizure of metal-sprayed shafts for bearings, more discussion of the principles of corrosion and examples of corrosive conditions that may be satisfactorily combatted by suitable metal spray coatings, with an augmented discussion of practical applications in general.

Much of the book is retained unchanged, but the revision is quite extensive. The bibliography has been brought through 1938.

Neither the original authors nor the reviser have any axe to grind. The discussion is well balanced; limitations as well as possibilities are brought out. This has been the standard reference book on metal spray, and the new edition maintains its position.—H. W. GILLETT.

PROTECTIVE COATINGS

PROTECTIVE COATINGS FOR METALS. *By R. M. Burns & A. E. Schuh. Published by Reinhold Publishing Corporation, New York, 1939. Cloth, 6½ x 9¼ in., 407 pages. Price $6.50.*

The protection of metal surfaces is one of the fundamental links in the chain of manufacturing and use of metals, and it is one of the last to be put on a scientific basis. This present work is a long step in this direction, making information, hitherto unpublished or so scattered as to

be difficult to find, into a unit which is available and interesting to almost everyone who has problems on the protection of metals.

In its general scope, this book, a revision of a previous work by H. S. Rawdon, covers the broad engineering features rather than abstruse scientific detail. It treats of the whole field from the widely used processing of steel before painting through paints themselves, thin hot-dipped and electroplated coatings to the heavy rolled-on metal-clad. The logical general plan enables the student who wishes to become familiar with the general subject, or the engineer who wishes to refer to some particular process, either to go through the book as a whole, gleaning the important points, or to readily find concrete data on a particular process and determine its relation to other possible processes. It is obvious that the authors, in addition to using the published literature and their own wide experience in the use and testing of coatings, have obtained the criticism and advice of specialists in the various types of coatings covered.

The authors bring to this work not only a knowledge of coatings themselves but a keen insight into the corrosion which occurs if metals are unprotected or improperly protected. Those who use protective coatings and wish to be certain that results are the best possible, or who manufacture or apply protective coatings and wish the work to be the most efficient possible in the light of modern developments, will be well advised to browse through this work as a whole and to keep it at hand for reference on specific problems.

—R. J. McKay.

Physics of Metals

Chemical Physics of Metals and Alloys (Chemische Physik der Metalle und Legierungen). *By U. Dehlinger. Published by Akademische Verlagsgesellschaft m.b.H., Leipzig, 1938. Cloth, 6½ x 9¼ in., 174 pages. Price 12 RM.*

This book, leaning strongly on a 10-year research program by the author and his Stuttgart associates is intended to give a comprehensive, accurate and clear (atomistic) picture of metals and alloys and of the underlying causes of reactions in them. The book is roughly subdivided into 2 main parts, one of which deals with the "states of equilibria" and the other with "reaction kinetics." The first part (90 pages) comprises chapters on thermodynamic analysis of equilibrium diagrams, electron distribution in metals and alloys, and ferromagnetism of elements and alloys. The second part, under the heading "kinetics," deals in 58 pages with diffusion and precipitation, transformations and plasticity. The latter, so important from an engineering point of view, is dealt with in only 5 pages. A carefully selected 6-page bibliography offers a valuable aid to further, more detailed studies.

Because of the author's own pioneering work on the subject, the book has a distinct personal note and some chapters, for instance the summarizing interpretation of transformation and precipitation kinetics, are unique. Whether the metallurgical engineer will complain of "too much physics and mathematics" depends entirely on his theoretical training, present interest and metallurgical activity—to the majority of readers of this magazine Dehlinger's book will, of course, hardly be useful. But it will be indispensable and attractive reading for physical metallurgists, chemists and physicists interested in metals and alloys, all of whom will certainly commend the author for his bold attempt to evolve, in semi-empirical fashion, useful generalizations from experimentally determined physical properties of metallic materials.

The book is excellent.—Erich Fetz.

Other New Books

Proceedings of the Midwest Power Conference. Vol. 2. *Published by Armour Inst. Technology, Chicago, 1939. Cloth, 6 x 9 in., 155 pages. Price $2.00.* Includes two excellent papers on creep properties and testing.

Applied Metallography (Angewandte Metallographie). *By R. & M. Niessner. Published by J. A. Barth, Leipzig. 1939. Paper, 6¼ x 9¼ in., 229 pages. Price 19 R.M.* Devoted chiefly to equilibrium diagrams—suitable as an advanced study text.

Patents and the Public Interest. *By H. A. Toulmin, Jr. Published by Harper & Brothers, New York, 1939. Cloth, 6 x 8½ in., 205 pages. Price $2.50.* Interesting, useful appraisal of invention and research as services to the public good.

Uses and Applications of Chemicals and Related Raw Materials. *By T. C. Gregory. Published by Reinhold Publishing Corp., New York, 1939. Cloth, 6 x 9 in., 665 pages. Price $10.00.* Lists actual or proposed uses for over 5,000 chemicals, with some metals classified as raw materials.

Metallography in Colors. *(Le Métallographie au Couleurs). By Joseph Malette. Published by Dunod, Paris, 1938. Paper, 5½ x 8½ in., 56 pages. Price 38 fr.* Includes 5 color plates, of dubius advantage over black and white pictures of the same fields. Metallographic and photographic technique are described.

Tool Making. *By C. B. Cole. Published by American Technical Society, Chicago, 1939. Cloth, 5¾ x 8½ in., 413 pages. Price $3.50.* Practical treatment, covering equipment and processes; includes much on heat treatment. A bargain.

Removing carburized Diesel engine camshafts from Hevi Duty Carburizing Furnace at Fairbanks, Morse & Co., Beloit, Wisconsin.

For carburizing the camshafts of their 4-cycle medium speed Diesel engines, Fairbanks, Morse & Co., use a Hevi Duty Vertical Carburizing Furnace. The vertical retort of this furnace permits the heat treating of these camshafts in an upright position to avoid distortion.

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CURRENT news

Foundrymen's 1940 Convention in Chicago

The board of directors of the American Foundrymen's Association at a recent meeting accepted the invitation from Chicago, strongly supported by the Chicago Chapter, A.F.A., to hold its 1940 Convention in that city, May 6 to 10 inclusive. In conjunction with the convention there will be a major exhibit of foundry equipment and supplies in the exhibit halls of the International Amphitheater. This will be the first exhibition of the Association since the one held in Cleveland in 1938, and the first major exhibit in Chicago since 1914. The exhibition will open Saturday noon, May 4, continuing through the evening, will be closed Sunday and reopen Monday, May 6, concurrently with the 44th annual convention. The Palmer House will be the headquarters.

Time Capsule Fascinates World's Fair Visitors

More than 2,000,000 World's Fair spectators have, since opening day, paused at the site of the Westinghouse Time Capsule and awaited their turn for a glimpse down the 50-ft. shaft of the "Immortal Well." As a result of the congestion created by these visitors, a passageway has been erected to assure everyone of access to the display. The crowd now moves to the well in single file, peers down the shaft, and proceeds to the remainder of the exhibit, which reveals the contents of the Capsule, the manner in which it was packed and how the Cupaloy tube is being preserved. [See METALS AND ALLOYS, November, 1938, page 311.]

WANTED

1 Used Rockwell Hardness Tester Model 1R or 3R, in good condition.

BOX MA-143

Convention of Steel Engineers

Over 5,000 steel mill engineers and operating executives from every steel mill center in the country will convene in Pittsburgh, Sept. 26 to 29. The Wm. Penn Hotel will be headquarters for the Association of Iron and Steel Engineers' 35th annual convention and Iron and Steel Exposition. A comprehensive technical program embracing virtually every field of steel mill engineering has been arranged. There will be 25 papers presented by leading authorities on steel plant practice.

The Iron and Steel Exposition, one of the outstanding features of this convention, will be housed under the same roof as the technical sessions. Over 100 steel mill equipment manufacturers have contracted for 20,000 sq. ft. of space to exhibit their latest designs and advancements. A large number have many outstanding new developments to offer the industry.

The engineers will visit two large steel plants in the Pittsburgh district: Irvin Works of the Carnegie-Illinois Steel Corp., and the Edgar Thomson Works of the same organization.

Standard Steel Samples

The National Bureau of Standards, Washington, D. C., has added new standard samples of high-nickel steel, high-sulphur steel, and leaded-steel to its list of standard samples.

The composition of the nickel steel, No. 126, is as follows: Ni 36.41, C 0.035, Mn 0.504, Si 0.109, Cu 0.098, and Co 0.008 per cent.

The high-sulphur steel, No. 129, has the following composition: C 0.131, Mn 0.855, P 0.109, S 0.260, Si 0.014, and Cu 0.166 per cent.

The leaded-steel, No. 130, is issued with the following certificate of analyses: C 0.454, Mn 0.687, P 0.021, Si 0.239, and Pb 0.203 per cent.

Standard nickel steel, No. 126, is priced at $2.50 per sample of 150 grams, and standard steels 129 and 130, at $2 per sample of 150 grams.

A complete list of the Bureau's standard samples, analyses, fees, etc., is given in the Supplement to Circular No. 398, which can be obtained free of charge upon application to the National Bureau of Standards, Washington, D. C.

● The Lewis Foundry & Machine Division of Blaw-Knox Co., Pittsburgh, has received an order from Tata Iron & Steel Co., Jamshedpur, India, for two Lewis 3-high sheet mills and accessory equipment. Part of an expansion program, these units will increase the India firm's sheet producing capacity by more than 100,000 tons annually.

Two More Companies Licensed to Produce Ledloy

The Inland Steel Co., Chicago, announces the issuance of licenses for the manufacture of Ledloy, to the Heppenstall Co., of Pittsburgh, and to the American Rolling Mill Co. of Middleton, Ohio. Many factors are said to account for Ledloy's increasing popularity, and the necessity for more sources of supply. Ledloy, the new, lead-bearing steel developed by Inland, is used for its free machining qualities which permit increases in machining speed from 50% to 200% on certain classes of work. With self-lubricating properties due to the lead content sub-microscopically dispersed throughout the steel, it is known to lengthen tool life as much as 300% in many instances. Ledloy required no different heat treatment than any other steel of the same type.

Additions to Battelle's Staff

Donald W. Scott, research engineer, has recently been added to the technical staff of Battelle Memorial Institute, Columbus, Ohio. He has been assigned to the concentration division which constantly works on developing and improving concentration methods and equipment for ores, coals, and other industrial materials. He is a graduate of the University of Minnesota, recently received his M.S. in mining engineering from the University of Alabama where he held a U. S. Bureau of Mines research fellowship.

Other additions to the Battelle Staff include Joe C. Danec, chemical engineer, who has been assigned to the division of process metallurgy. Mr. Danec is a graduate of Lafayette College, Easton, Pa.

Theodore E. Pochapsky, a June graduate of Ohio State University, has been assigned to the ceramics division, which is interested in all fields of ceramics.

Foundry Equipment Manufacturers' Annual Meeting

Arthur J. Tuscany, Penton Building, Cleveland, executive secretary and treasurer, Foundry Equipment Manufacturers Association, announces that the annual meeting of the association will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 6 and 7. The meeting, which was scheduled originally for earlier in the year, was postponed among other reasons so that it might come during the fall season and permit meeting at a resort location.

Galvanizers' Annual Meeting

The semi-annual meeting of the American Hot Dip Galvanizers Assn., Inc., was held on Thursday and Friday, Aug. 24 and 25, at the Hotel Statler, Cleveland. At the technical session the following papers were presented:

"Grief in the Galvanizing Shop," by J. B. Tate of The Witt Cornice Co., Cincinnati.

"Temperature Regulation," by Clem Stein of International-Stacey Corp., Columbus, Ohio.

"Aluminum in Hot Dip Galvanizing Baths," and also a report on Embrittlement of Malleable Iron, by Wallace G. Imhoff, technical director of research to the Association.

The technical session was followed by a group luncheon at which the Association was the host. A cocktail party, and banquet with music and entertainment, followed in the evening.

● The title of H. W. Graham, for many years general metallurgist of the Jones & Laughlin Steel Corp., Pittsburgh, has been changed to director of metallurgy and research. His assistant, C. C. Henning, becomes general metallurgist of the company. The new titles, it was announced, involve no change in the organization set-up of the department. Mr. Graham's entire professional experience has been with J. & L., where he came in June, 1914, from Lehigh University. C. C. Henning has also been identified with Jones & Laughlin during practically his entire professional career, joining the company in 1915 in the Pittsburgh Works Metallurgical Department.

● Jack M. Noy has been employed by the Foote Mineral Co., Philadelphia, as a research chemist.

Metal Film for Movies

Motion pictures, complete with sound effects, were projected successfully from a thin metal film for the first time after 27 yrs. of trials and failures, according to a despatch to the N. Y. Times from Berlin, Germany. The demonstration was made before an audience of experts at the German Institute of Technical Research in Berlin.

The process was developed by Dr. Semenitz in cooperation with the institute, and the results are declared "satisfactory, though requiring slight improvements in sound reproduction."

Metal film, thinner than its celluloid counterpart and far more resistant to wear and exposure, is made either of rolled iron bands with aluminum plating or of aluminum alloy. The pictures, instead of being projected by the transmission of light through the film, as in the celluloid process, are thrown on the screen by reflection on a highly polished surface.

It was declared that the metal film would be used primarily for purposes for which celluloid film has proved inadequate and that it would not—at least for the time being—replace celluloid film.

One use of the new film could be the taking of ultra-slow motion pictures, since the metal can pass through the camera at far greater speed than the celluloid, which would tear under the same stress. It will also be of great value for keeping photographic records because of the durability factor. In this case the fact that pictures can be taken on both sides of the film is claimed a great advantage.

● The Metallizing Co. of America, Inc., Los Angeles, Cal., has recently opened a sales and service office at Newark, N. J., 602 Academy Bldg., 17 Academy St.—William McMakin in charge. Complete parts on Mogul metallizer guns are available for prompt shipment, as well as metallizing wire. Free engineering service concerning metallizing problems is also available.

● George W. Jernstedt, 23-year old chemical engineer of the meter division, Westinghouse Electric & Mfg. Co., Newark, N. J., has been awarded the Benjamin Garver Lamme Graduate Scholarship for the year 1939-40. The scholarship provides $1500 tuition and expenses for advanced study. The scholarship is awarded annually by the Westinghouse company to one of its young engineers, chosen by a committee on the basis of scholastic attainment, capacity for achievement and personality.

● The Lewis Foundry & Machine Division of Blaw-Knox Co., Pittsburgh, has received an order from Forges de Leval Aulnoye of northern France for one Lewis 3-high sheet mill. In accordance with a recent arrangement covering the manufacture and sale of certain Blaw-Knox products for European markets, Detombay of Charleroi, Belgium, will assist in producing this mill. Lewis Foundry will do the engineering and provide certain parts and all of the rolls.

● The Hercules Powder Co., Wilmington, Del., has announced the appointment of Dr. Emil Ott as director of research. With headquarters in Wilmington, Dr. Ott will be in charge of all company research. O. A. Pickett continues as director of the Experiment Station. Dr. Ott brings to his new position a scientific background, based on practical operating and teaching experience. He was born in Zurich, Switzerland, and was graduated from the Swiss Institute of Technology in that city, specializing in chemistry, physics, and other branches of natural science.

● The steamer L. E. Block, flagship of the Inland Steel Co. ore freighters, has again broken the record for carrying the largest cargo of iron ore. She loaded 15,778 gross tons at Superior, Wis., on Saturday, July 22, breaking her own record cargo made in June of this year.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

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POSITION WANTED: Metallurgist, Bachelor and Masters degrees from prominent universities. Seven years' experience in steel mill control, development and claim investigation—largely in tin plate but includes auto body sheets. Young, single, at present employed but seeking larger opportunities. Box MA-154.

POSITION WANTED: 1939 graduate of the Michigan College of Mining and Technology. B.S. degrees in metallurgical engineering and chemistry. Location no object. Age 23, married. Excellent references. Porcelain enameling and other protective coatings work of special interest but any type of employment will be gladly accepted. Box MA-155.

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Ajax Electric Company, Inc. ..... Outside Back Cover
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Ajax Metal Company ..... Outside Back Cover
Aluminum Company of America ..... MA 520, MA 521
American Bridge Company ..... MA 528
American Car and Foundry Company ..... MA 529
American Chain & Cable Company, Inc., Page Steel & Wire Division ..... MA 541
American Electric Furnace Company ..... MA 515
American Gas Association ..... A 20
American Gas Furnace Company ..... MA 537
Anaconda Sales Company ..... MA 565
Andrews Steel Company ..... MA 518
Armstrong Cork Company ..... MA 532

Baker & Co., Inc. ..... MA 536
Bausch & Lomb Optical Company ..... MA 551
Brown Instrument Company ..... MA 553

Carborundum Company, Refractory Division Inside Back Cover
Carnegie-Illinois Steel Corporation ..... A 2, A 3
Climax Molybdenum Company Insert between pages 290 and MA 513
Columbia Steel Company ..... A 2, A 3, MA 528
Crucible Steel Company of America ..... MA 531

De Witt Operated Hotels ..... MA 546
Dow Chemical Company, Dowmetal Division Inside Front Cover
Driver Company, Wilbur B. ..... MA 556
du Pont de Nemours & Co., Inc., E. I. R. & H. Chemicals Department ..... MA 517

Electric Furnace Company ..... MA 534
Electro Metallurgical Company ..... A 21

Fitzsimons Company ..... MA 559

Great Lakes Steel Corporation ..... MA 557

Handy and Harman ..... MA 516
Hevi Duty Electric Company ..... MA 563
Hotel Adelphia ..... MA 542

Illinois Testing Laboratories, Inc. ..... MA 537
International Nickel Company, Inc. ..... A 22, MA 519
Iron and Steel Exposition ..... A 14, MA 543

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Leitz, Inc., E. ..... MA 560

Mahr Manufacturing Company ..... MA 529
Mallory & Company, Inc., P. R. ..... MA 555
McKenna Metals Company ..... MA 549
Meehanite Metal Corporation ..... A 24
Michiana Products Corporation ..... A 13
Minneapolis-Honeywell Regulator Company .... MA 553
Monarch Steel Company ..... MA 559

National Industrial Advertisers Association .... MA 567
National Steel Corporation ..... MA 557
Norton Company ..... A 19

Olsen Testing Machine Company, Tinius ..... MA 547

Page Steel & Wire Division, American Chain & Cable Company, Inc. ..... MA 541
Pangborn Corporation ..... MA 527
Pittsburgh Lectromelt Furnace Corporation .... MA 526

Republic Steel Corporation ..... A 4 ,A 5

St. Joseph Lead Company ..... MA 514
Scomet Engineering Company ..... MA 556
Scott Company, Henry L. ..... MA 548
Spencer Turbine Company ..... MA 535

Taylor Sons' Company, Charles ..... A 11
Thermal Syndicate, Ltd. ..... MA 549
Timken Roller Bearing Company Steel & Tube Division ..... A 6
Titanium Alloy Manufacturing Company ..... MA 525

Union Carbide and Carbon Corporation ..... A 21
United States Steel Corporation ..... A 2, A 3, MA 528
United States Steel Products Company A 2, A 3, MA 528

Westinghouse Electric & Manufacturing Company .. A 18
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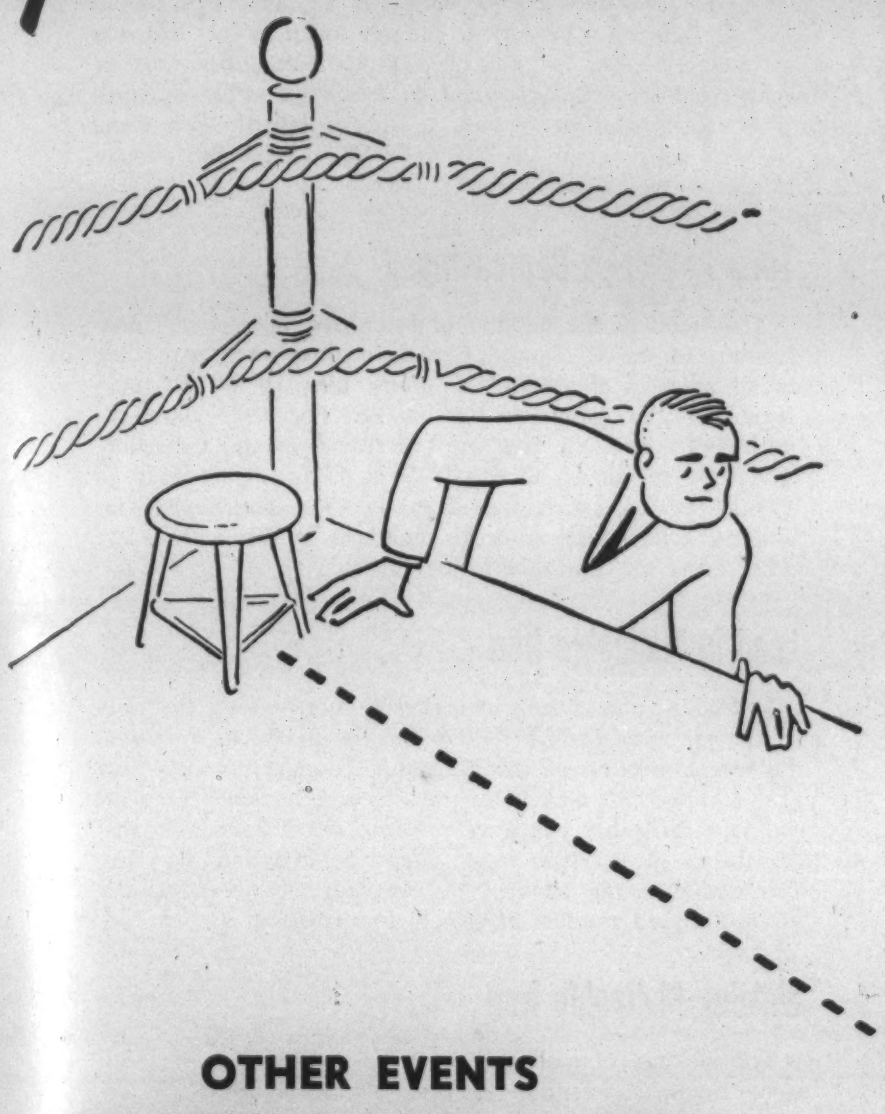

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3-39

trends

By Edwin F. Cone, Editor

More Electric Steel

It is the opinion of one engineer, conversant with trends in the electric steel industry, that more large electric furnaces are being installed and are likely to be installed than ever before. The tendency will be to produce in electric furnaces some alloy steels now made in the open-hearth because it is claimed, the trend in the cost of electric steel is downward.

More Electric Steel Foundries

An analysis of Penton's Foundry List, 1939-1940, published in *The Foundry,* July, 1939, shows an increase of 10 electric steel foundries in the U. S. for 1939 over 1937 or 215 in all. The Canadian total is 24 against 23 in 1937. Pennsylvania leads with 32 and Ohio is second with 26, both showing gains in the 2 yrs. of 4 and 1 respectively. California, which ranks third with 20 electric steel foundries, lost 3 in the period.

More Non-Ferrous Foundries

"Exclusive non-ferrous foundries" in the U. S. in 1939 total 1370, a gain of 10 over 1937, according to a recent analysis of Penton's Foundry List, 1939-1940. The gain in Canada has been 11 or 92 in all.

Heat-Treating Practice

A new angle to heat treating has appeared. The Industrial Furnace Manufacturers Association, Inc., has launched a program designed to improve metal products subjected to heating operations—the "uniform metal products program." Continual variations in physical properties are frequently attributed to the material but this is more often due to improper methods of heating and cooling; improvement in shop practice is one broad aspect of the program, it is contended.

Plastics vs. Metals

Replacement of metals by plastics, particularly in airplanes and automobiles, is being seriously considered here and abroad and much is being accomplished. The metal industry must watch this trend carefully for plastics may become a serious competitor for metals in structural applications.

Large Exports of Scrap Copper

In the agitation which has been broadcast regarding exports of scrap iron and steel, attention has not been called to exports of "old and scrap copper." Official data show that during 1937, 1938 and to May 1, 1939 (28 mos.), American exports have totalled 92,576,126 lbs. (41,328 gross tons) at a value of $8,784,112 or about $21.25 per ton. Doubtless a large quantity of this has gone to Japan! Of the over 14,500,000 gross tons of scrap iron and steel exported in the 75 months to April, 1939, about 53.5 per cent has gone to Japan! This trend in both copper and steel is too heavy under the circumstances.

Total Foundries Decreasing

The trend in the number of foundries, ferrous and non-ferrous, in the U. S. and Canada is downward, according to an analysis of Penton's Foundry List, 1939-1940, published in *The Foundry,* July, 1939. For 1939 compared with 1937 the U. S. has lost 144 foundries and Canada 6. The total in the U. S. for 1939 is 4776 against 4920 in 1937. The 1939 Canadian Total is 457. The depressions and the establishing of large foundries by automobile and other users are probably major causes.

Lead in Malleable Iron

Is lead to play a role in malleable iron—along the lines of the famous "Ledloy"? Touceda is quoted as saying at the recent meeting of the Malleable Founders' Society that lead additions to malleable iron "have a tendency to make ordinary malleable pearlitic." Slight improvement in machinability in pearlitic irons might be expected, he said. The additions ran about 0.25 per cent with the quantity in the finished product extremely low.

Welding Malleable Iron

The welding of malleable iron is being studied and with some favorable results. A new process was briefly described at the meeting in June of the Malleable Founders' Society. According to *Steel,* Touceda was quoted as saying that the new process is probably best suited to welding thin-walled castings. At the A.S.T.M. meeting in June, other phases of malleable iron welding were discussed.

Standardization

Evidence of the increasingly important extent to which standardization is now a factor in industrial affairs is found in the acceptance of membership in a new advisory committee of 13 of the American Standards Association by such leading executives as Sloan, Stettinius, Teagle, Budd, and others.

Cooperative Effort

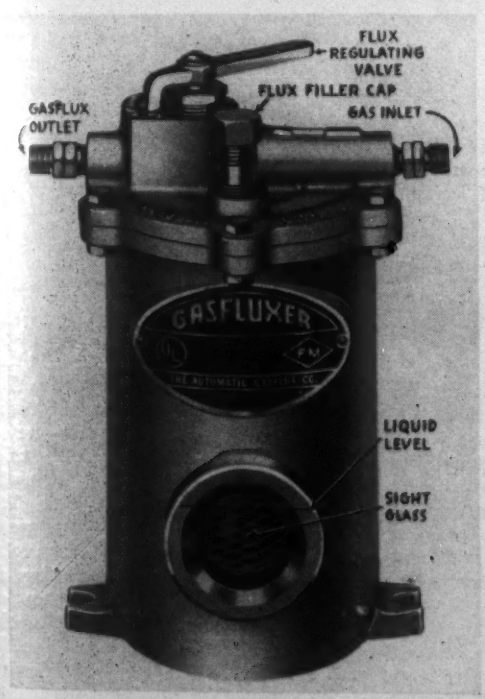
It is the opinion of S. A. Knisely, director of advertising, Republic Steel Corp., as expressed in an address before the Malleable Founders' Association, that, in order to secure new markets for a product, cooperative efforts of a group are more efficient than individual efforts. "Practically all manufacturing is face to face with the new competition of industry against industry. This can be met only by pooling your combined resources in the interest of the entire group."

New Equipment and Materials

All-Metal Fluxers

The line of liquid gasfluxes and gasfluxers, described some time ago, has been augmented by the addition of a new line of improved all-metal fluxers or dispensers of various sizes and by a new liquid "Gasflux" of superior quality. Standard portable equipment is now offered at a low price which is said to justify its purchase for maintenance as well as production work. It will be recalled that under the "Gasflux" process, the liquid flux is picked up by the gas in vapor form and delivered in the flame to the work actually in hand.

Some advantages of this process in brazing



and in non-ferrous welding, as claimed by the Automatic Gasflux Co., Cleveland, are that it:

1. Places the flux in the flame—at the exact point where it is needed; 2. Produces stronger and cleaner welds; 3. Makes non-porous welds; 4. Eliminates necessity for pickling; 5. Does away with dipping rod in flux or brushing on flux; 6. Makes brazing possible at lower temperature; 7. Reduces fumes to a minimum; 8. Uses less gas, less oxygen and less rod; 9. Employs the correct amount of flux as volume of flux to gas is adjustable through a flux regulating valve; and 10. Operates at generally lower cost.

These claims as to the advantages of the Gasflux process are said now to be substantiated by testimonial letters and repeat orders for material from a number of prominent users. The new all-metal Fluxers or dispensers now offered to the market are made of cast aluminum, combining light weight with strength, and in various sizes suitable.

One special feature of the new Fluxer which is said to present a real advantage to the user is the graduated flux regulating valve, which

> Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts not more than 2 in. wide.

makes it possible to vary the amount of Flux used on different jobs. Its operation is said to be simple, merely involving the turning of a small lever from one index to another to give a variable gas and flux mixture. Gasflux is placed in the new unit through a filler cap in the head and may be removed through a drain plug on the side at the level of the bottom. Visual inspection of Gasflux level is provided through a small glass window on the front. Two simple connections make it possible to cut the fluxer into the gas line without difficulty, designed for efficient and easy operation.

In addition, gasflux reserve tanks or reservoirs which can be mounted on top of the fluxer by removing the filler cap, are available and while not absolutely required for operation are recommended for efficiency and convenience.

The standard Model R portable unit weighing only 6 lbs. 3 oz. is now offered to the market at a new low price. This unit is described as of a size and so designed that it can easily be moved from place to place wherever work may be, in any branch of maintenance welding. Both Underwriters Laboratories, Inc., and The Associated Factory Mutual Fire Insurance companies have tested the equipment here described and have accepted it for formal listing.

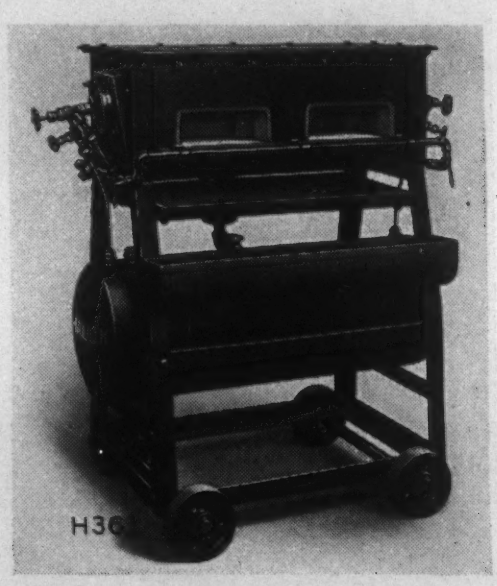
Magnus Electrex Cleaners

A new and better method is claimed available for the cleaning of metal surfaces for electroplating or other finishes. It involves a slightly different method, utilizing a new type of cleaning agent of superior effectiveness to materials so far used. This material is called "Magnus Electrex." It is offered in a graded series of electroplaters' metal cleaners based upon the Magnus wetting agent Saponex. This unique material is said to have rapid wetting and penetrating and dispersive effects. It is acid and hard water-proof, and free rinsing.

Electrex is claimed to provide the most effective method yet developed for electro-cleaning and is particularly valuable before bright plating. It usually eliminates any need of scouring. Steel or copper surfaces can be completely cleaned in the one electro-cleaning operation, of polishing or buffing compound, almost all drawing compounds, smut, finger marks and shop dirt. Degreasing, pre-cleaning, scrubbing or hand wiping are rendered unnecessary by this method which is a boon before bright plating, it is claimed. Electrex is offered in 4 grades by the Magnus Chemical Co., Garwood, N. J.

Rivet Heating Forge

A double chamber, 2-burner rivet heating forge, unmounted or mounted on wheels is offered by the Hauck Mfg. Co., Brooklyn. The two openings are each 9 x 3½ in. and the two heating chambers 13 x 9 x 6 in. Burner



consumes 2 gals. of oil per hr. and 10 cu. ft. of air per minute at 60 lbs. per sq. in. pressure. Oil tank holds 25 gals. Normal heating capacity is said to be 800 ¾ x 3-in. rivets per hr. Unit is 700 lbs. net weight. Wheels have 7-in. diameter and 2-in. face.

High Speed Forging Press

Florence Pipe Foundry & Machine Co., Florence, N. J. (R. D. Wood Co., selling agents) recently completed construction of an extra high speed 2,000-ton forging press with which it is possible to obtain 10 complete operating cycles per minute.

The power unit consists of a radial piston pump having a capacity of 83 gal. of oil per minute at 2500 lbs. per sq. in. pressure, operated by 125 h.p. motor. Operating during the working cycle is automatic, the ram returning to open position and remaining for the period determined by the operating cycle before again descending upon the work. Working pressures exerted upon the work may be regulated and set at any point from zero to 2,000 tons.

The ram is 45 in. in diameter, 4 ft. 6 in. long, weighs 16,000 lbs., and is cast in Meehanite metal so as to provide, it is said, the unusual physical properties required for such high speed, high pressure action. The four-ram guide plates, one on each side of the column, are of the same material. Operation is entirely automatic, controlled by a push button panel.

Electric Arc Welder with Little Vibration

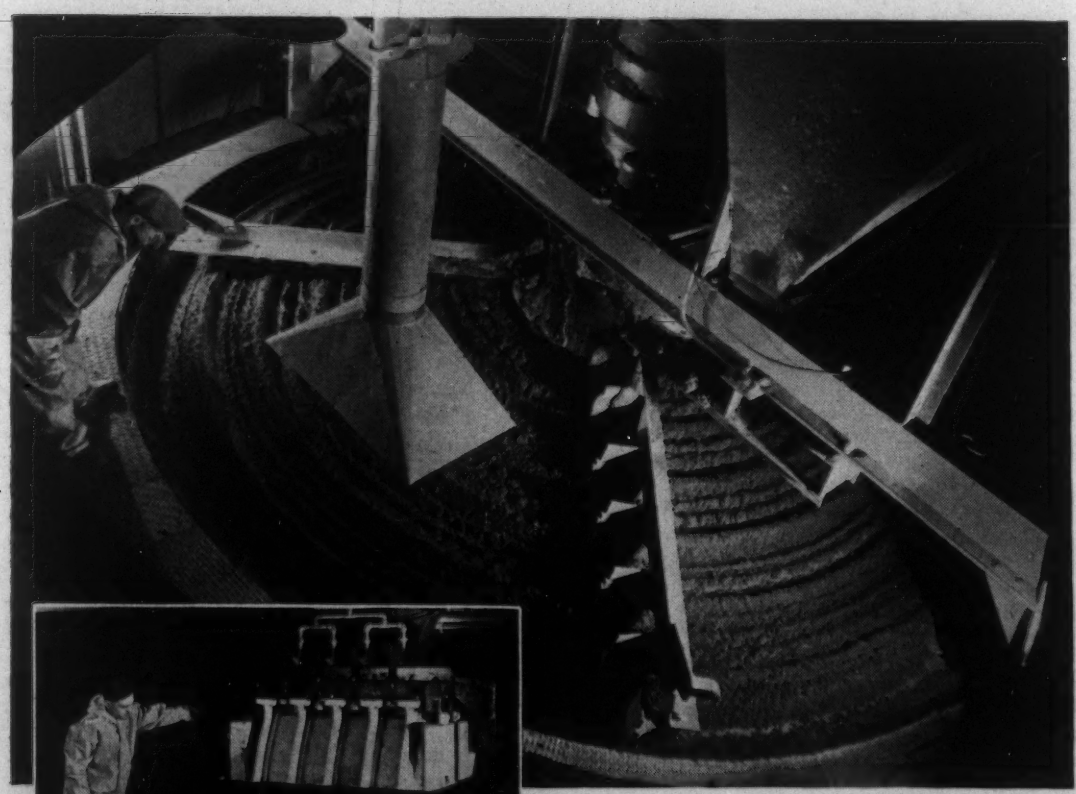
When the Harnischfeger Corp. of Milwaukee were developing the new "P&H Model WA-200" square frame arc welding service, it was their goal of developing a smaller, more compact machine, more readily adaptable to production line methods of manufacture. Yet withal, they wanted a machine far more rugged and rigid than any which had ever been developed.

After many months of research and experimentation entailing grueling tests, Harnischfeger engineers developed a design unique to the arc welding industry and which takes concrete form in the new Model WA-200 welder. This square frame, extremely rigid welding generator is built with but two main parts: The rugged frame and the rotating member. This type of frame, used for the first time in this modern welding unit, is described as extremely rigid and designed to protect bearings against misalignment and wear. Its huskiness is due to heavy members welded into a single unit which cannot "give" and there are no belts or rivets to work loose. This rugged construction, coupled with perfect static and dynamic balance of the rotating member, has resulted, it is said, in the elimination of the vibration formerly expected in the ordinary electric arc welder.

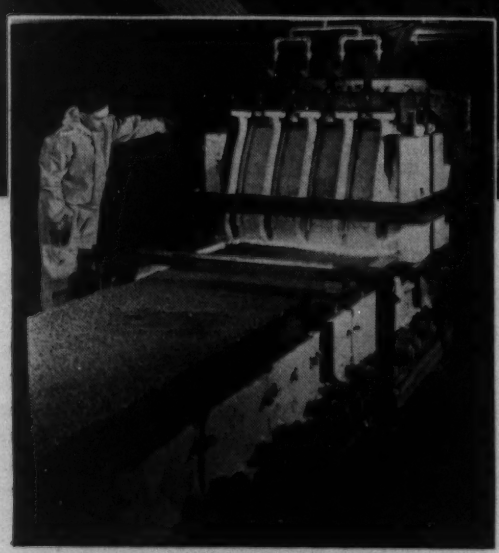
So drastic has been this reduction in vibration that, during tests in the manufacturer's shop, an ordinary coin was stood on edge and a pencil was balanced on end on the frame while the unit was operating at full capacity. The reduction in vibration, only one of the many claimed advantages of this new arc welding service, will naturally greatly increase the life of the welder and minimize the service requirements throughout its use. This departure from the conventional round type welding generator frame also promotes the use of units in parallel—one easily being stacked upon the other.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 8 of a Series



CHARGING HEARTH OF ROASTERS



SINTERING MACHINE

ROASTING and SINTERING. Zinc concentrates from the New York State mines of the St. Joseph Lead Company arrive at the company's smelter at Josephtown, Pa., containing about 58% zinc and 32% sulphur. The first operation is a roasting process to reduce the sulphur. This is accomplished on three 21-foot diameter Nichols-Herreshoff furnaces. These furnaces have 12 hearths and the concentrates are heated and dropped from hearth to hearth by mechanical rabbles. The resultant calcine contains 67 to 68% zinc and about 1% sulphur. The sulphur dioxide gas passes on to the contact acid plant. The second operation is the sintering of the calcine. This is done on 42" x 44' Dwight-Lloyd gas fired sintering machines. This operation agglomerates the zinc ore and eliminates lead and cadmium. The sinter, which has a hard open lacelike structure, contains about 59% zinc and less than ¼ of 1% sulphur. After screening, this material is conveyed to the furnace bins where it awaits treatment by the electrothermic furnaces, for conversion into St. Joe slab zinc.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE
NEW YORK

ELDORADO 5-3200

PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Electrode for Spot Welding Non-Ferrous Metals

An electrode has been put on the market by the Electroloy Co., Inc., 1600 Seaview Ave., Bridgeport, Conn., which is claimed to control pressure in spot welding non-ferrous metals.

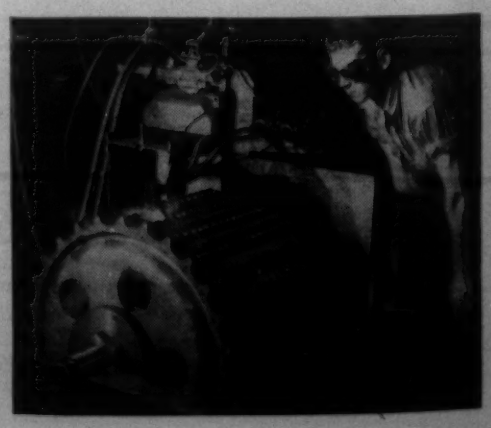
Briefly, its construction is a tube, threaded or tapered at the bottom to take a standard welding tip. Just above the tip there is brazed one end of a tubular flexible copper braid. From the upper end of this inner tube project small water-cooling attachments. An outer tube makes an easy sliding fit over the inner tube. This tube is brazed to the top end of the flexible braid. At the top end of the outer tube is screwed a cage containing a spring and centralizing washer and with a graduated scale to indicate pressure in pounds. The pressure may be adjusted by screwing the case up or down on the outer tubing. In this unit, only the welding tip, the light inner tube and the water cooling attachments are movable. The weight of this piece is usually between 1 and 2 lbs., as contrasted to the 150 lbs. of the average spot welder. It is claimed that this electrode will move tremendously faster than the electrodes in conventional spot welder.

An electrode of this type has produced successful welds in non-ferrous metals and alloys which, it is claimed, have heretofore been welded only with great difficulty. In welding non-ferrous metals, it is important, says the company, that the electrode follow up the softened metal with great rapidity at the moment that the metal reaches a plastic or liquid state, because the temperature range for welding these metals is extremely limited. It is therefore claimed the heavy pressure from the conventional spot welder is a disadvantage particularly as to rapid movement, excessive deformation at the weld and lower resistance. There appears, it is stated, to be only one method for making the electrode assembly rapid moving without increasing the pressure beyond practical limits. This method is to materially decrease the mass and friction of the moving part.

The construction described above is claimed to fulfill these requirements.

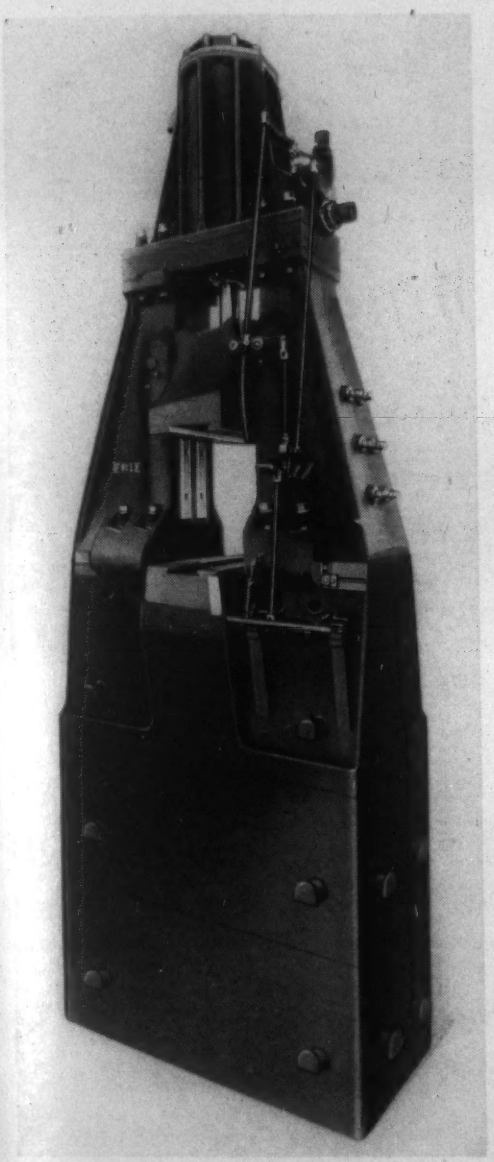
Sixteen At a Time

Sixteen sprockets gang-hardened at a time! That's how one manufacturer has solved a knotty production problem of flame-hardening the teeth of rear drive sprockets for one of America's most popular tractors. The trick in doing this work successfully is to make sure that the nested parts are clamped tightly together, since any space between the parts would result in a non-uniform case. In this instance, the 16 sprockets, supported by an arbor, are drawn together by taking up on the nut shown in the illustration. Each of the sprockets is 26⅛ in. in diameter, has 27 teeth, and is made of S.A.E. 1045 steel. Hardening is performed with two 2 D.P. gear-hardening heads attached to blowpipes which are driven by a cutting machine. A speed of 7 in. per min. produces a ⅛-in. to 3/16-in. depth of case having a hardness of 70 Scleroscope.



Largest Hammer in the United States

There is now being installed in a midwestern city, a steam drop hammer which will be larger by a considerable margin than any machine of this type in the western hemisphere. It is the second largest hammer in the world. This machine, rated as a 35,000-lb. hammer, has an actual weight of ram, rod, and piston of about 42,000 lbs. It will handle in addition, a top die weighing 10,000 lbs. The total weight of the machine is 880,000 lbs., of which 350 tons is in the anvil. The top section of the anvil weighs 130 tons and each of the bottom sections, 110 tons. The overall height is 40 ft. 6 in. Of this, only 23 ft. 6 in. will be above the floor line when



the machine is installed. The construction of the foundation required excavation to the depth of 36 ft. Dies up to 44 in. wide can be used. They can be supported without overhang front and back, up to a length of 90 in. It is expected that dies longer than this will be used regularly, and special construction is employed to prevent angular misalignment of the long dies.

This Erie steam drop hammer made by the Erie Foundry Co., Erie, Pa., will be used to make forgings of light metal alloys. The largest hammer of this type in the world at present is being used for similar work in a European plant. Two hammers, duplicates of the present one, now in the United States, are now under construction for installation in Europe. The hammer which, previous to this installation, was the largest in the country, is used for drop forging crankshafts for Diesel engines. The total weight of the present hammer is more than 40 percent greater than that of the previous record holder.

Oil Well Casing

The A. O. Smith Corp., Milwaukee, is now a full-line manufacturer of oil well casing, with a complete range of A. P. I. standard sizes down to 5½ in. in outside diameter and in wall thicknesses to meet practically any casing need. Simultaneous with the company announcement comes word that Smith Casing is now available in four grades including a new and still higher yield strength casing, called "Super Yield Casing."

With a minimum yield point of 105,000 lb. per sq. in., Super Yield Casing is made in the smaller sizes for extremely high collapse pressures. "It is the first standard casing with such high physical strength," according to the company statement, "and it offers new economy with safety, particularly for deeper holes. This newest Smith contribution to the oil industry, marks the latest milestone in casing history. Again, a substantial advance has been made toward the ultimate in setting depths as well as in the efficient utilization of the steel in casing."

Involving radically new methods of manufacture, the new small sizes, like all Smith Casing, are made from rolled steel plates. This permits thorough examination of the steel before manufacture and assures uniform wall thickness. It is produced in accordance with A. P. I. standards. The new sizes are manufactured in average lengths of 50 ft., this factor considerably shortening the running time for the strings by requiring fewer joints. Already a considerable quantity has been successfully set in the field.

A Pore-Free Metallic Coating

The Standard Steel Spring Co., Coraopolis, Pa., has recently introduced a new pore-free coating, "Corronite". Data on this pore-free metallic coating will be made available for the first time at the Metal Show in Chicago, Oct. 23 to 27. This coating is claimed to greatly exceed the corrosion resistance of present coatings and compares favorably in cost with present commercial coatings and thus will open up many new applications for tonnage steel.

Andrews

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IRON AND STEEL products

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NEWPORT, KENTUCKY

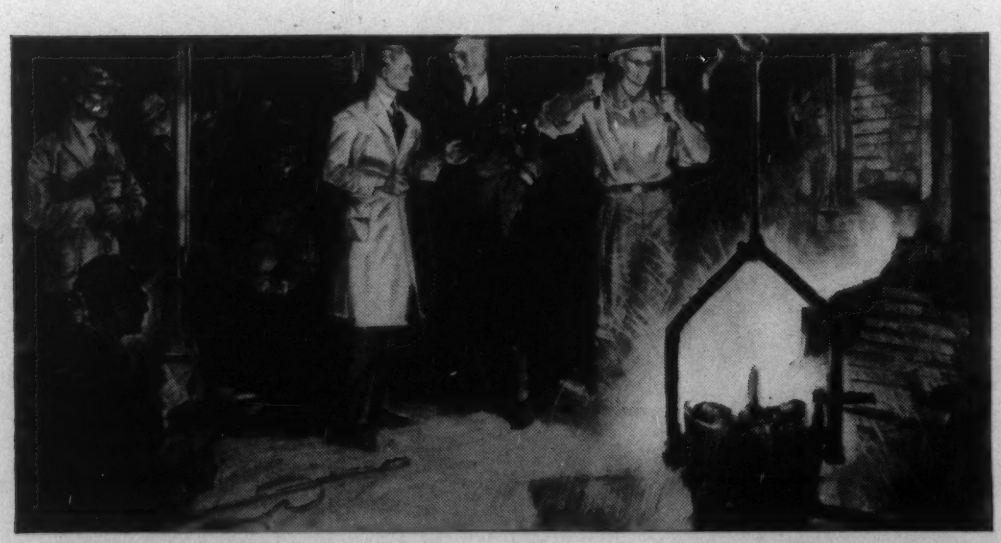
DIVISIONS
THE NEWPORT ROLLING MILL COMPANY
THE GLOBE IRON ROOFING & CORRUGATING CO.

IT WILL PAY YOU TO SEE THESE FEATURES AT THE J&L METAL SHOW EXHIBIT

Booth B—117 • NATIONAL METAL EXPOSITION • CHICAGO

The J & L Pilot Plant Laboratory

Significant of the steel industry's progress in research is the J & L Pilot Plant Laboratory where, with unique facilities, J & L metallurgists and engineers bridge the gap between scientific theory and commercial practice. At the J & L Metal Show exhibit you will see a scale replica of this Pilot Plant and have the opportunity to learn more of the work carried on by the J & L Research and Development Division.



In the J & L Pilot Plant Laboratory this small scale open-hearth furnace is used to develop and prove new formulas and new practices in steel-making. Here steel is made by the pound to improve it by the ton.

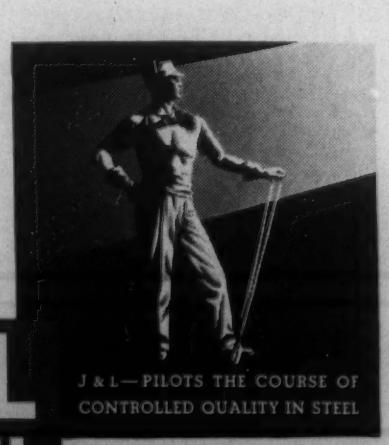
On these small rolling mills, in the J & L Pilot Plant Laboratory, rolling information is developed on experimental heats of steel. Thus new and better working steels are created for you.

The Invention That Brings Scientific Control to the Bessemer Process

A feature of the Jones & Laughlin Metal Show exhibit is a graphic illustration of the exclusive J & L Bessemer Flame Control — a development that introduces a new era in steel-making. With natural color transparent photographs the Bessemer flame, in its progressive stages, is shown as it appears to the human eye and a large graph traces the flame as seen and recorded by the photo-electric cells and control instruments. Also on display are parts made of Bessemer Flame Control Screw Stock, in leading automatic screw machine shops, under regular production conditions.

OTHER J & L EXHIBITS include Cold Finished Steel, Jalcase Steel, Strip and Sheet Steel, Forging Steel, Jalcold Tin Plate, Mastercraft Spring Wire, Cold Heading Wire, Gilmore Wire Rope, Tubular Products and Coke By-products.

Make the J & L Booth, B-117, the center of your activities at the National Metal Exposition and, remember, it will pay you to see the many and informative features of the J & L exhibit.



JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

PITTSBURGH, PENNSYLVANIA

J&L STEEL

J & L—PARTNER IN PROGRESS TO AMERICAN INDUSTRY

"Falex"—A Mineral Insulation

The Faville-Levally Corp., 140 S. Dearborn St., Chicago, offers a mineral insulation for industrial furnaces and boilers available under the trade name "Falex." This material, a vermiculite product, is made from genuine zonolite selected ores, the granules being formed by multiple expansion of the ore by the application of heat in specially designed processing furnaces.

It is claimed that Falex vermiculite offers a 3-way heat saving to a greater extent than any other insulation: (1) The multiple dead air cells in the granules prevent transfer of heat by conduction; (2) the highly reflective surfaces in the granules prevent heat loss by radiation; (3) the granules pack snugly, forming a barrier to heat flow by convection through the insulation.

The material is pointed to as chemically inert, and will not deteriorate, corrode or affect any material with which it is in contact; the granules are rot-proof, fire-proof, dielectric, odorless, clean, vermin-proof, and extremely light in weight, it may be used without damage to the material or impairment of its efficiency at hot face temperatures up to its fusion point of 2250 deg. F.

The granular material is used on furnace roofs either loosely or covered by a plastic coating. It may be used as a filler for light weight concrete, or with any suitable binder. It is claimed unexcelled for loose fills between brickwork and steel casings, and is widely used for retarding the rate of cooling of objects requiring a slow cool.

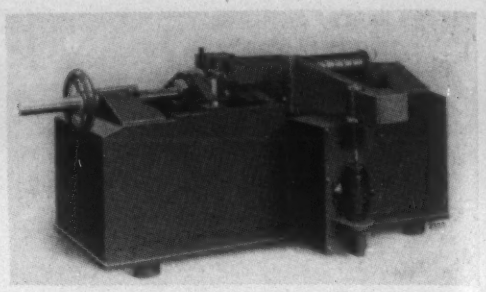
It is also available in the form of plastic coatings, blocks and brick.

Fatigue Testing Machine

What is known as a "Push-Pull Machine Pulsator," system Schenck, with resonance drive is described as a radically new type of fatigue testing machine.

The purpose of this machine serves mainly to determine the fatigue strength of metals and machine-members under pulsating or reversed push-pull stresses. To some extent, bending tests can also be carried out. On designing the machine, special consideration was given to attaining high testing loads and high test speeds of 3000 r.p.m. and more. The construction is described as very simple; bearings, slides, pumps and pipes have been avoided deliberately in order to diminish the sources of dangers in continued service.

The machine forms an oscillating system which works in the vicinity of its natural fre-



quency and consists mainly of the spring for applying static stresses, of the oscillating spring and of the specimen. The oscillating spring, a double-acting blade-spring, rests diagonally to the longitudinal axis of the machine and produces, when oscillating, exact axial push-pull forces. The oscillating spring is excited by small unbalanced wheels on one of its free ends. The other free end is compensated by weights in such a way that the two spring-halves have exactly the same natural frequency. The latter mainly determines the test speed of the machine. The elasticity of the specimen has no influence on it.

The use of oscillating systems in the technique of research is claimed the only way to drive high speed machines producing high testing loads, with as few accessories, space and power consumption as possible. For this, however, it was necessary to meet the three following requirements first, on which the use of the resonance drive depends: (1) avoidance of the peak of resonance; (2) vibrationless installation; (3) adjustment of the amplitude of oscillation. Consequently, the machine works on the rising portion of the resonance curve.

A Coating for Plating Racks

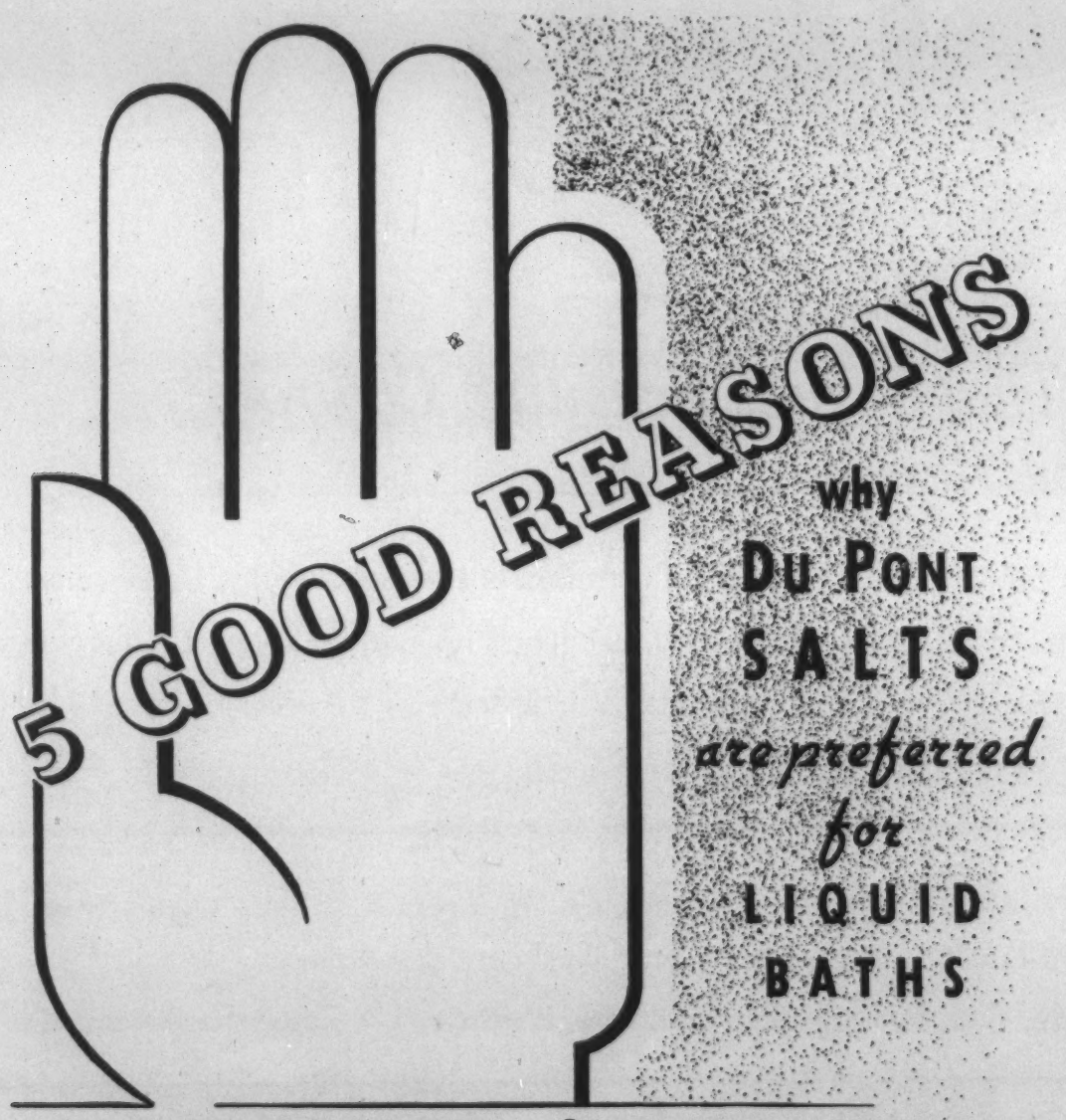
"Unichrome Rack Coating-W" is a new rack coating material which has been developed by United Chromium, Inc., 51 E. 42nd St., New York, primarily for the purpose of coating plating racks of all descriptions with a material which will not be affected by boiling cleaners or by plating solutions in general use, including chromium, and which contains no ingredients which are in any way harmful to any plating bath into which the coated rack is introduced.

The material is white in color so that any uncovered portions of racks may be readily seen. It does not blister or crack, and many racks coated with this material have stood up without any signs of deterioration over a period of months of continuous use in the plating cycle.

Recommended procedure for coating racks is to dip the rack in Unichrome Rack Coating-W, each coat being subsequently force dried at a temperature of about 200°F. The drying operation after each coat requires about 1 hr. Ten coats are usually applied.

The cost of Unichrome Rack Coating-W is $8.70 per gal. in 5-gal. containers. A special thinner in connection with this material is required, selling at $3.40 per gal. in 1-gal. containers.

Specific instructions for dipping facilities and baking facilities and full instructions for procedure are furnished by United Chromium to companies wishing to use Unichrome Rack Coating-W on their own racks.



WIDE OPERATING RANGE: Consistently good results can be obtained within wide variations of temperature and operating conditions.

ECONOMY: A result of unusual stability and efficiency in operation; low rate of replenishment and small dragout losses.

UNIFORMITY: All du Pont salts are uniform mixtures with a guaranteed cyanide content.

SERVICE: Our trained metallurgists are at your call to cooperate with you in the solution of any liquid bath problems. Just call or write our nearest office.

STABILITY: Du Pont salt baths have a low rate of decomposition. Bath activity is easily maintained with moderate replenishment.

At the Chicago
NATIONAL METAL SHOW
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DU PONT

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The R. & H. Chemicals Department
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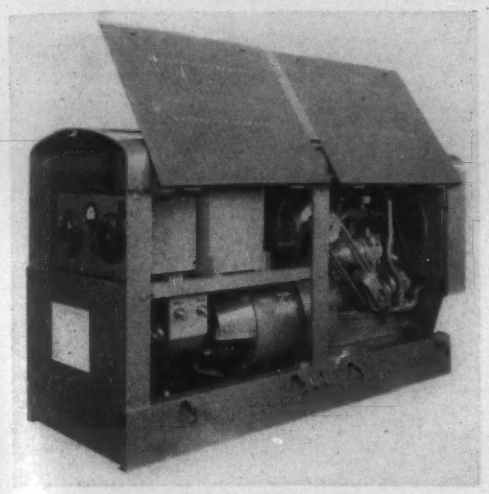
District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

Diesel Engine Driven Arc Welder

A new 300-amp. diesel engine driven arc welder, equipped with gasoline engine starting rather than the conventional motor starter with storage batteries, claimed a decisive advance in diesel design, is announced by The Lincoln Electric Co., Cleveland.

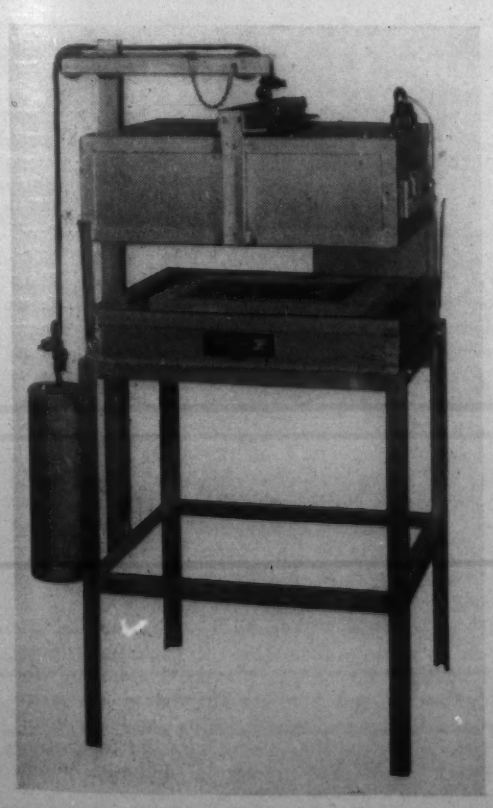
This new welder is said to simplify the use of diesel power, first made available to users of engine driven arc welders by Lincoln engineers. It compares favorably with gasoline engines in dependability of starting, simplicity, weight and cost, as well as in operating speed. The gasoline engine used for starting the welder is a small auxiliary mounted above the diesel engine. It is started by means of a hand crank. A belt drive, engaged by means of a clutch, connects the starting engine to the diesel.



The new Lincoln diesel driven welder is said to cut fuel costs 33 to 86%, depending upon the type of fuel oil used. The diesel uses only 1.5 gal. of fuel oil per hour at full load operation, as compared with 2.75 gal. of gasoline per hour in the conventional gasoline engine welder drive. Total savings, including other items are, in many cases, as high as 40 c. per hour. The arc welding generator used on the new welder is the 300-amp. "Shield Arc SAE" unit, equipped with dual continuous control. Other features claimed for this generator include: Extra wide welding range; independent excitation; laminated magnetic circuit; high capacity; high efficiency; cool operation; all-purpose meter; and all of the other features which long experience has shown are necessary to ease of operation, proper performance and maximum welding economy.

A Heating Furnace

A new type of furnace which has been introduced by the Cooley Electric Mfg. Corp., 215 S. Senate Ave., Indianapolis, Ind., is designed for heating for quenching flat tools. It consists of a hearth having dimensions of 12 by 12 in. An insulated lifting roof is provided to give access to the work when heated, and heating elements are located in the roof itself. The chamber, when the furnace is closed, has a height of 2 in. The furnace is furnished with 2.1 kw. at 220 volts.



Kennametal Tools

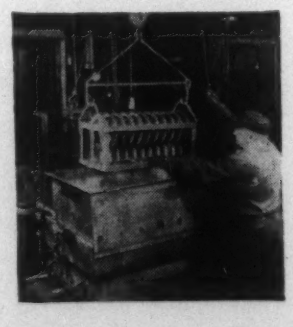
The McKenna Metals Co., 158 Lloyd Ave., Latrobe, Pa., announces two new forms of standard Kennametal single point turning, facing, and boring tools for machining steel, either annealed, as forged, as cast, or in the heat-treated form up to 550 Brinell. These designs are said to overcome the problem of convenient chip disposal in cutting steel at the highest speeds practical with Kennametal tools. These chip breaker forms of Kennametal tools are claimed particularly useful in shaft turning work, steel roll and projectile turning jobs, and in general where large volumes of chips are produced per minute.

These tools with chip breaker forms are preferably re-ground in a fixture with diamond impregnated bakelite wheels, or they may be ground by hand with special loose bond silicon-carbide grinding wheels, to maintain this simple chip breaker form. These tools cut at speeds 3 to 6 times as great as with tools of high-speed steel. The smooth, non-galling cutting action of Kennametal creating a minimum of "built up edge", even with low tool rake, results in easy machining of steel, it is claimed. Under ordinarily good conditions of machine rigidity, Kennametal tools of these designs will rough and finish in one operation. The manufacturer will be pleased to furnish full information on request.

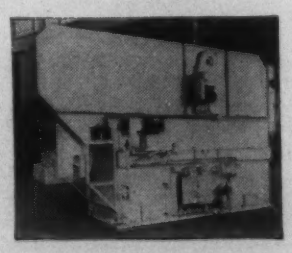
METAL CLEANING ENGINEERS
DETREX
DETROIT REX PRODUCTS

1940 CLEANING METHODS

For Finishing and Heat-Treating



Vapor-slush type Detrex Degreaser used with electric lift to clean parts after oil quenching.



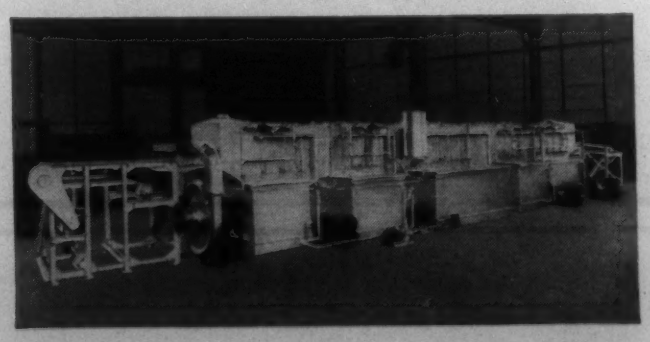
Conveyorized 3-dip Detrex Degreaser used for cleaning prior to painting, plating or inspection.

Timed to your 1940 production are, the Detrex-engineered cleaning equipment and solvents.

Your requirements for fast, flexible and economical cleaning will be met by a Detrex Degreaser.

Using stabilized safety solvents—either "Pern-A-Clor" or "Triad"—the metal parts or assembled products emerge clean, warm and dry, immediately ready for painting, plating, heat-treating or inspection.

Complete information on the Detrex equipment or solvents best suited to your particular requirements is yours for the asking. Or better yet, let a Detrex engineer consult with you.



A typical Detrex spray installation consisting of alkali washer, rinses, chromic acid, Bonderite, and air blow-off.

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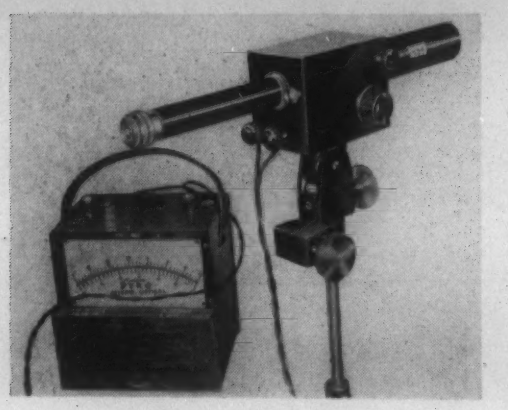
A Micro-Optical Pyrometer

This new instrument is claimed to permit measuring the temperatures of very small objects such as incandescent lamps, filaments, etc., and for laboratory and scientific research work. This precision instrument has a 20-fold magnification of the object which is provided by means of an optical arrangement of high candle power and 37 mm. aperture. The image of the smallest wire or filament under observation will



fill the optical field and completely cover the tip of the pyrometer filament range.

The instrument operates on the principle of disappearing filament and is furnished with a direct reading scale range from 600 to 3000 deg. C. and higher. The ammeter is compensated against variations in room temperature and has a so-called suppressed zero point in order to make better use of the scale, but only as far as is permissible with regard to constancy. Battery consists of four ordinary commercial flashlight cells. The unit is furnished with rigid support and tripod, the instrument holder being equipped with a fine precision double worm gear arrangement for the most delicate adjustments in any desired direction. Write for special literature to The Pyrometer Instrument Co., 103-105 Lafayette St., New York.

A W-Ti Cutting Tool

Discovery of a metallic compound capable of cutting and smoothing the toughest metals and harder than the hardest steel used to manufacture tools is reported to the American Chemical Society by Philip M. McKenna of the McKenna Metals Co., Latrobe, Pa.

The new compound, because of its ability to retain a sharp cutting edge at high temperatures, will increase the speed with which stainless steels can be machined, according to the report. Economy will result from doing away with the necessity of removing and sharpening tools at short intervals.

Metals alloys made from the new compound are said to be ideal for work done on hard, tough metals which do not chip off in little pieces while being cut but form a continuous coiled springlike filament. Such metals are among the most difficult to work because they usually dull one part of the cutting edge of a tool and cause the remaining sharp portion to "crater", or disfigure, the surface being out.

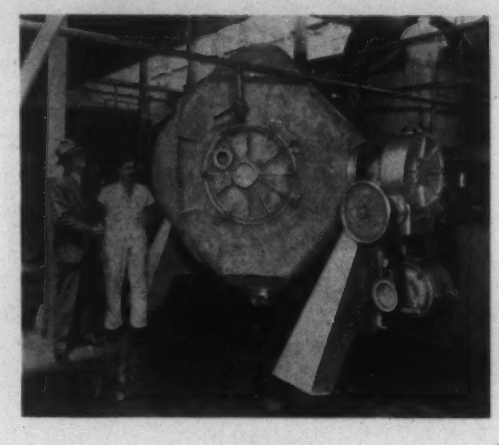
Given a rating of 9.8 on the scale used by metallurgists to represent the hardness of a material, the new compound is 0.2 softer than a diamond, which, with a rating of 10, is the hardest substance known. The material is obtained by heating tungsten, which is used for making filaments for electric lights, titanium, a metal found in common clay, and carbon in crucibles made from pure graphite, the material from which lead pencils are made.

The mixture is heated in a bath of molten nickel to a temperature of 2,000 deg. for a prolonged period. Upon cooling, it is separated from the nickel by dissolving it first in aqua regia, and finally in hydrofluoric acid in platinum dishes. The report states that the alloys are made in special furnaces by means of powder metallurgy. An important characteristic of tool compositions made from the new compound is its resistance to grain growth, which is the formation of large crystals or clusters of crystals it is pointed out. When used on lathe tools, blanks of these hard new alloys are brazed, a kind of welding, into recesses in steel shanks with silver solder, bronze or pure copper. Die or nozzle inserts may be shrunk into place usually with the use of a little silver solder.

Aluminum Castings in Largest Churn

The largest churn in the country has just been built by the Jensen Creamery Machinery Co., Oakland, Cal. and installed in the Challenge Cream and Butter Association plant at Oakland. It is constructed from two sandcast aluminum shells which, together, weigh 1500 lbs. In tests, this unit has churned 660 gals. of cream into 2580 lbs. of butter in 30 to 45 min. Because of the cubical design, the churn is reported to be capable of churning butter in 50 per cent less time than the conventional roll type units.

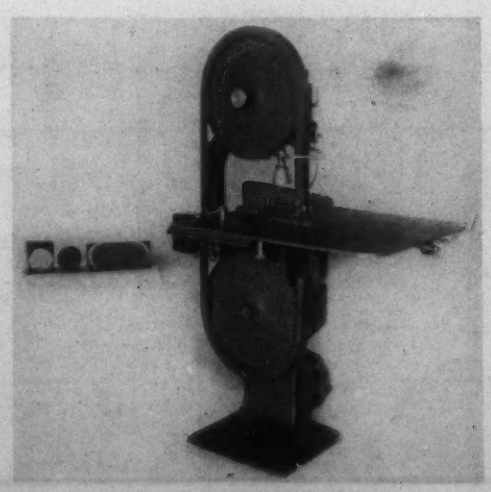
The huge aluminum castings which make up the body of this new dairy machine were cast at the Los Angeles foundry of the Aluminum Co. of America, and are among the largest aluminum castings ever made. The patterns were so large that special doors had to be built in order to move them out of the pattern shop into the foundry for casting. Aluminum was used in the construction of this churn in order to obtain the advantages of the metal's lightness and non-contaminating properties.



Band Saw for Metals

Wm. Laidlaw, Inc., Belmont, N. Y., announces what is said to be the first metal cutting band saw which is capable of cutting accurate radials with diameters ranging from 1.5 to 9 in. The machine, known as the "Type JMR-20 Band Saw," is powered by a 1-h.p., 1750 r.p.m. motor and offers 2 speed ranges of 50 to 365 ft. per min. or 100 to 725 ft. per min.—saw travel.

Frame, saw wheels, guide arm, and table are Meehanite in order to provide strength, rigidity, and fatigue endurance. Ball bearing roller saw guides are used with blades which may range from ¼ to ⅜ in. 2.5 in. clearance is provided beneath the guide arm of the radial control screw.



New Alloy for Fish Hooks

"Z" Nickel, the new heat-treatable nickel alloy containing approximately 98 per cent pure nickel, is being used for fish hooks. They are rust proof, even in salt water, and their mechanical properties after heat treating provide them with exceptional strength and stiffness without destroying required ductility, it is claimed by the International Nickel Co., Inc., New York.

At present the hooks have been produced entirely on an experimental basis, but their possibilities are being thoroughly investigated with the idea of beginning commercial production as soon as possible.

A Lathe Chart

A convenient lathe chart which gives the recommended speeds for cutting steels of any range of hardness with Kennametal, the new carbide tool bit tip material, has just been issued by McKenna Metals Co., 158 Lloyd Ave., Latrobe, Pa. Cutting speeds recommended on the chart range from 20-30 surface ft. per min. for work of 65 Rockwell C (682 Brinell) to 300-400 surface ft. per min. for work of 25

Recommended Speeds for Cutting Steels
of any range of hardness with
KENNAMETAL
(The Steel Cutting Carbide Tool)

HARDNESS OF WORK Rock. C	Brinell	Scler.	PREFERRED SPEED Surface Ft. Per Min.
65	682	93	20 to 30
60	601	83	30 to 50
55	545	75	50 to 60
51	495	69	60 to 80
45	427	62	80 to 100
40	370	54	100 to 150
35	323	46	150 to 220
30	276	42	220 to 300
25	249	38	300 to 400

For Lower Hardnesses Use Any Speed Above 250

Rockwell C (249 Brinell). For work of lower hardness any speed above 250 surface ft. per min. is recommended. It will be noted that these speeds are from two to six times greater than those commonly used with high speed steel tools.

The chart also illustrates two designs for grinding tools so as to produce (1) crescent shaped chips, easily shoveled up, and (2) a coiled chip of tough steel. The reverse side illustrates the correct tool shape for interrupted cutting (jump cuts) with Kennametal tools; also the terms used in describing angles on single point cutting tools. Smaller rake angles are possible with Kennametal tools than with steel tools because Kennametal does not gall from the moving chips.

Printed in black ink on yellow stock, the new chart is extremely legible, and it is varnished on both sides for easy cleaning. It is furnished with a hole punched at the top for hanging on lathes. Any interested machinist or machine shop executive may have this chart without cost.

Heavy-Duty Welding and Heating Blowpipe

Literally hundreds of such metalworking operations as forging, forming, straightening, bending, and pressing can be effectively and economically performed with the aid of the intense, localized heat of the oxy-acetylene flame. Of late, the usefulness of the oxy-acetylene flame for these "smithing" operations has been greatly increased by the availability of the large-capacity heating blowpipe. This blowpipe, distributed by The Linde Air Products Co., New York, and known as the "Oxweld (Type W-26) Heavy-Duty Welding Blowpipe," is for welding and heating ranges above those which can be handled by the ordinary blowpipes. It delivers a tremendous amount of heat to a localized area, and does this so quickly that metalworking and heat treating can be accomplished at top speed, it is claimed.

Extensions for the welding head are available for extra-heavy work, doing away with the necessity for heat shields. The operator works in comfort, away from the source of heat, and finds the blowpipe, even with the extension, easy to handle because of its excellent balance.

Its applications cover a wide range, including use in the fabrication of tanks and pressure vessels, for making locomotive boilers, for straightening and bending ship plate, for wrinkle-bending large-diameter pipe, and for similar heavy work. It can also be used for lighter work as well as for certain flame-hardening operations.

Current Metallurgical Abstracts

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1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

EDWIN F. CONE, SECTION EDITOR

2a. Ferrous

Decomposing Crude Phosphates by Smelting with Soda-Slag (Der Schmelzaufschluss von Rohphosphaten mit Soda-Schlacke) K. H. HENNENBERGER. *Stahl u. Eisen,* Vol. 59, June 1, 1939, pp. 662-663. Practical. With the increasing use of sodium carbonate for desulphurizing pig Fe, the problem has arisen of utilizing the resulting slag. This has approximately the following composition: 23 to 35% Na_2O, 22 to 24% SiO_2, 3 to 10% Fe, 2 to 8% Mn, 2 to 10% CaO, 1 to 5% MgO, 1 to 5% Al_2O_3, 0.5 to 3% P_2O_5, 0.1 to 0.6% V, 2 to 15% S. This soda-slag has been utilized for decomposing raw phosphates in a rotary tube furnace. One of the first problems was to find a suitable refractory for the lining of the furnace. A rammed-in lining of Portland cement and Portland cement clinker was satisfactory but tar dolomite proved even better. Compressed bricks of this material lasted over 2 months. Soda-slag was mixed with the raw phosphate at about 1 : 1. Additions of 1 to 5% Na_2CO_3 and 2% NaCl were beneficial in raising the ammonium citrate solubility, this being as high as 84%. Slowly cooling the mass from the furnace instead of quenching it raised the ammonium citrate solubility still more. Nearby farmers who used the fertilizer were well satisfied with it. More scientific tests will be made by German government agricultural stations. SE (2a)

2b. Non-Ferrous

Extraction of Tellurium from Electrolytic Copper Slimes. A. I. GAEV, T. S. DOLZHENKO & P. V. TRUTNEV. *Tsvetnye Metal.,* No. 10, Oct. 1938, pp. 64-70. Experiments conducted to develop more efficient methods of extraction of Te are described. These methods were introduced at Pyshma and Kyshtym Copper Works, Russia. Before the introduction of the improved method at the Pyshma Works only 15% of the Te contained in the treated slimes was dissolved out in the process of extraction of Se; the remainder of Te went into the slag. Experiments showed that the slags that were insoluble in water could be made soluble by adding soda to the charge. The solution is best effected at 75-90° C. using slag ground to —40 mesh with agitation. Oxide of Te is precipitated from the hot solution by H_2SO_4. The precipitate is filtered off, washed in water to remove all of the (SO_4) ions, in which process from 0.4 to 1.8% of the Te is lost, and dried. The oxide of Te is reduced by melting with charcoal at 800°-900° C. The Te in the gases is recovered by Cottrell precipitator. Se and Te are recovered from the dust by leaching out the Se anhydride and Te and precipitating Se by SO_2; the recovery of Se varies from 70-97%, and that of Te up to 26%. Some Te is precipitated together with Se. New American methods of precipitating Te from Se acid solution before precipitating Se have not been tried. A study of concentrations of Se and Te, acidity and other factors led to the development of a method of extraction of Te in order to lower the Te losses in the precipitation of Se, which is briefly as follows: Acidity is raised to 110 g. HCl/l. of solution; Se is precipitated by H_2SO_4 until its content in the solution is lowered to 0.04g./l. The residue contains 30-50% Te (This precipitate is made into slag and treated as slag.) The filtrate is diluted to 65 g. acid/l., heated, and the Te is precipitated by SO_2 at 75° C. Complete precipitation of Te is obtained. BND (2b)

3 Melting, Refining and Casting

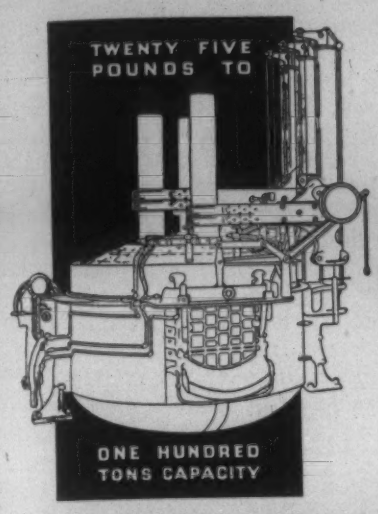
Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5

C. H. HERTY, and G. L. CRAIG, SECTION EDITORS

Position of the Development of Centrifugal Casting in Germany. W. A. GEISLER. *Foundry Trade J.,* Vol. 61, July 6, 1939, p. 5; July 13, pp. 30-32; July 20, pp. 48-50. Review. Up to the year 1894 there were 9 German patents relating to centrifugal casting, but these were not all of German origin. In Germany, cast iron pipes are made by the Briede-de Lavaud process, *i.e.* in water-cooled molds. (As de Lavaud utilized Briede's idea of the longitudinal movement of mold and feed device, the process is known in Germany as the Briede-de Lavaud process.) The stress on the steel molds caused by the heat and oxidation of the surface is considerable. Originally, Ni-Cr steel was employed for the mold, but later this was replaced by Cr-Mo steel, the surface of which was found to be much more resistant. In a process patented by Fried. Krupp A.-G. the formation of thermal stress cracks on centrifugal casting molds is reduced by subjecting the inner surface of the molds to treatment by nitriding.

Cast iron pipes made in water-cooled molds have to be heat-treated in order to eliminate stresses and remove hard outer zones. During the last few years a number of patents have been granted relating to processes for producing unchilled castings in water-cooled centrifugal casting molds. The necessity to anneal the pipes is obviated in the centrifugal casting process employing sand molds. In Germany, attempts have also been made to effect the centrifugal casting of socket pipes in the vertical position. A large number of cylinder liners, bushings for valve seats and brake drums for motor vehicles are also being made by the centrifugal casting process. In 1928 W. Raym obtained a patent for the process of producing solid ingots made of 2 or more kinds of metal.

The successful introduction of the centrifugal casting process in the case of cast iron pipes also led non-ferrous foundries to make exhaustive experiments with this process. It was found that considerable improvements in quality were possible, as compared with sand casting, because of the exceptional refinement of structure through the two-fold effect of centrifugal force and rapid, uniform cooling. In Germany, pipes of considerable size are made of non-ferrous metals. At first special brasses containing 54-62% Cu, were cast centrifugally. In addition to Zn, such alloys also contain mainly Ni, Mn, Al and Fe, which together may amount to about 7%. Subsequently the centrifugal casting process was applied to red brass and bronze alloys. Centrifugal casting of these alloys exhibited over the greater part of their periphery crater-like cavities, rendering the pipes useless. The method finally adopted to avoid these defects consisted in selecting a mold material that would prevent the harmful absorption of gas upon the entry of the metal, *i.e.,* upon splashing; Cu and various Cu alloys were found to be suitable as mold material. The cast iron molds are lined with Cu sheets 1-3 mm. thick. In this way it is possible to cast centrifugally all the alloys used today, such as bronze, red brass, Ni-Cu, Monel metal, etc., in a satisfactory manner and quite free from porosity, because all contact of molten metal with the cast iron or steel mold is avoided. AIK (3)



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AJAX-NORTHRUP FURNACES

Ajax-Northrup high frequency induction furnace in operation in the Purdue Metallurgical Laboratory. Graduate student, C. H. Watkins, lifts the cover off the crucible while graduate student, D. J. Mack, reads the temperature of liquid alloy cast iron with an optical pyrometer.

At PURDUE

"The Ajax-Northrup high frequency induction furnace purchased five years ago was used originally in the School of Chemical Engineering for routine laboratory and research work. More recently it has been largely used in the preparation of alloys, and also in some experiments with glass.

"We have found it to be very satisfactory, and it is used in the new course in the metallurgical laboratory for our undergraduates."

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14-C

3a. Ferrous

High Purity Iron. Although highly pure (99.99%) iron is a long way from being a tonnage product like some of its ultra-pure non-ferrous cousins, for certain electrical applications it is practically indispensable, so that interest in methods for producing it is keen. Iron of this purity has in the past been made in tiny lots from iron carbonyl powder. Recently two other methods have been described.

Engineers of the Westinghouse Co., according to one description ("Production of Iron of High Purity." *Ind. Heating,* Vol. 6, July 1939, pp. 600-601, 628) have succeeded in producing a 99.99% pure iron by melting and refining electrolytic iron. The electrolytic product, after refining in a high-frequency induction vacuum furnace contains as its 0.01% impurities chiefly C, but traces of O, Si, S, Ni, P, Mn, Zn, Mo, Cu, Pb, Sn, Be and Ti in amounts from 0.005 down to 0.0001% can be detected spectroscopically. Ingots of 200 lbs. are made that are forged at 1600° F. to small rods and then heated at 2000° F. in a hydrogen atmosphere to eliminate surface oxidation.

Iron of slightly higher purity has also been prepared (but on a much smaller scale) from reduced iron oxide by J. G. THOMPSON & H. E. CLEAVES ("Preparation of High Purity Iron." *J. Research, Nat'l Bur. Standards,* Vol. 23, July 1939, pp. 163-177). The iron, in the form of 1-lb. ingots, was made by reducing purified iron oxide to sponge iron, melting the sponge iron, and remelting under hydrogen and in vacuo. The ingots were examined by spectroscopic and chemical methods, for the presence of 55 possible impurities and their total found to be less than 0.01%. The major impurities are non-metallic, chiefly O and S, with traces of C, P, N and H. Copper is the only metallic impurity in 7 of the ingots; others contain small amounts of Si and occasional traces of Al or Be from the refractories.

Ha + WAT (3a)

A New Cupola Melting Process (Ein neues Kupolofenschmelzverfahren) W. ZÖLLER. *Giesserei,* Vol. 26, June 30, 1939, pp. 336-339. Descriptive. Conventional cupola operation is said to be an inefficient attempt to follow blast furnace practice with a furnace of an entirely different character. The principle of heating in the cupola should be the best possible utilization of the heat of the fuel by radiation, rather than by convection. A new method has been developed in which the heat transmission takes place, not in the counter flow manner of burden and gas as in the blast furnace, but through heat radiated from a coke layer on top of the burden. This layer is heated to white heat and comes in contact with the cold burden and therefore creates a maximum temperature gradient for radiation. The charging of the furnace for this procedure is intermittent so that each charge is finished individually. Design of the cupola to reduce heat losses to a minimum, especially when the bell is opened for a new charge, and some experimental heats are described. A trial run gave the following results as compared with a normally melted charge of the same composition.

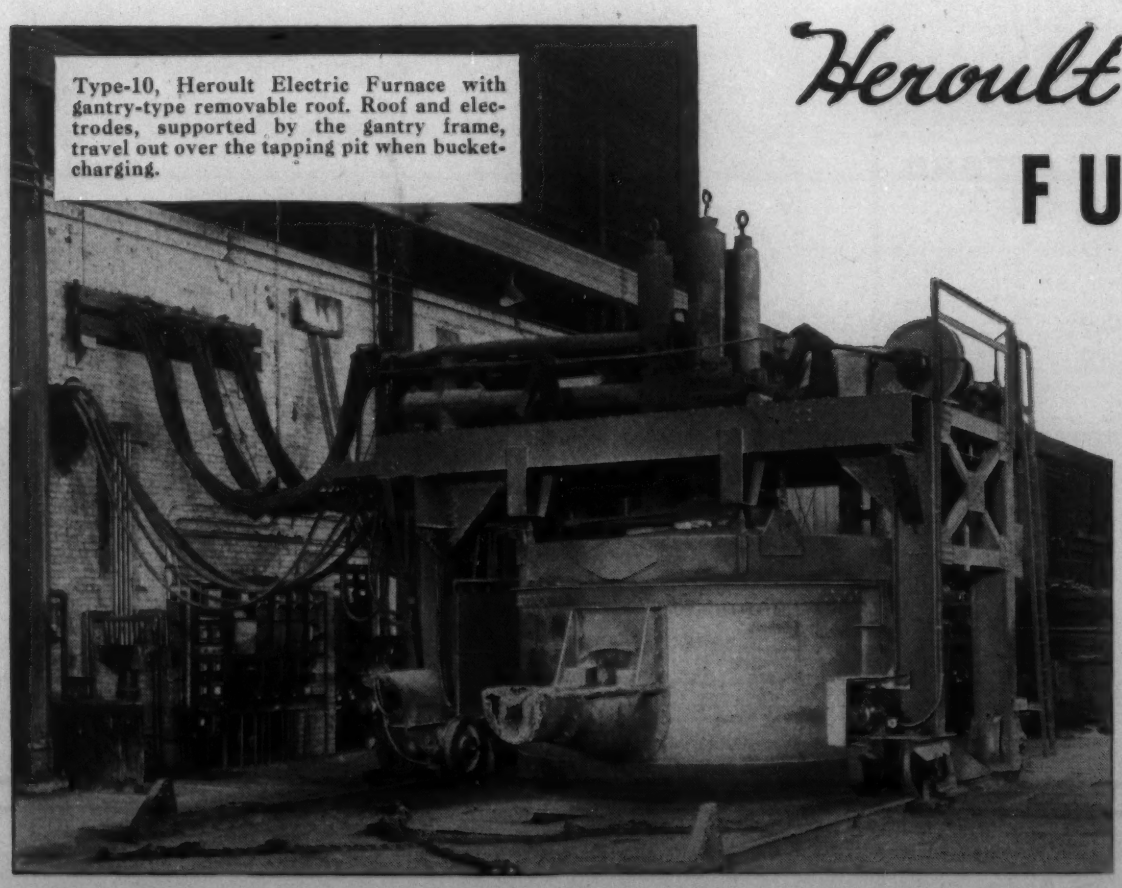
	% C	% Si	% Mn	% P	% S
Normal	3.55	1.89	0.74	0.14	0.089
New Method	3.38	1.92	0.72	0.11	0.093

The mechanical properties were as follows:

	Bending Strength	Tensile Strength	Brinell Hardness
Normal	54,000 lbs./in.²	29,000 lbs./in.²	189
New Method	65,000 lbs./in.²	37,000 lbs./in.²	220.5

Although no particular care could be taken in the experiments to keep the radiation losses low, the heat consumption was no greater than for the normal process—and this with a saving in coke and with a higher melting capacity. Ha (3a)

The Open-hearth Furnace for Melting Malleable Cast Iron. G. R. SHOTTON. *Foundry Trade J.,* Vol. 61, July 27, 1939, pp. 58-59; Aug. 3, 1939, pp. 79-81. Practical. Furnace design, furnace body, regenerators, reversing valves, maintenance of the furnace, gas producer, operation of the furnace, melting losses, fuel and total operating costs are discussed. Since the furnace proper is constructed of silica bricks, it is necessary to maintain its temperature fairly near to melting temperature when not in operation. Violent fluctuations of temperature would result in spalling of the silica bricks and necessitate more frequent shutdowns for repairs. It is also important that the temperature of the regenerative chambers be maintained near working temperature. The furnace can be operated continuously for long periods, and will, in fact, yield better results under such conditions. Since the supply of molten metal for the foundry is intermittent, it precludes the use of a fully-mechanized continuous molding system. Under certain conditions this may be a disadvantage. On the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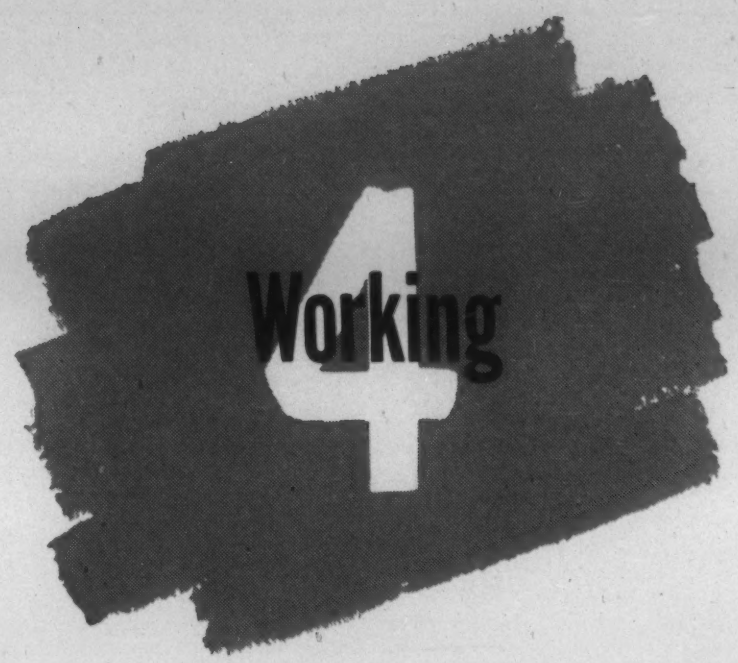
other hand, the intermittent supply provides a large bulk of metal of uniform analysis, and therefore permits close control of composition. Melting losses are fairly constant. The molten metal can be superheated to suit foundry requirements. The open-hearth furnace is a comparatively cheap melting unit when operated near maximum capacity, and might be considered an economical proposition even when operated down to about ½ capacity. On smaller outputs, however, the operating costs may quickly become prohibitive. AIK (3a)

3b. Non-Ferrous

Melting Practice for Light Alloys. There is a general recognition today of the effect of melting conditions on the quality of Al and Mg alloy castings, but not an overabundance of knowledge of the influence of individual factors, and particularly, of the effects and avoidance of specific contaminants. J. LAING and R. T. ROLFE ("Non-ferrous Foundry Practice. XXV, the Aluminum Alloys," *Metal Industry, London,* Vol. 54, June 2, 1939, pp. 581-586) maintain that the most prejudicial impurity in Al-Si alloys is Fe, the presence of which in excess of 0.7-0.8% causes a rapid decrease in ductility. The effect of Fe can largely be corrected by Mn or Co additions. Copper and Sn have a deleterious effect on corrosion resistance; Cu increases strength but reduces ductility, whereas Sn reduces both. Ni and Zn as impurities are said to have little effect on mechanical properties. A. J. MURPHY, S. A. E. WELLS and R. J. M. PAYNE ("The Effect of Melting Conditions on Light Alloys," *Foundry Trade J.,* Vol. 60, June 15, 1939, pp. 528-531) focus attention on the effect of certain extraneous conditions on contamination of Al and Mg alloys. The above-mentioned danger of Fe pick-up must be remembered when the use of cast iron or steel melting crucibles for Al alloys is under consideration. No case of contamination of industrial Al alloys by graphite or silicon carbide crucibles has been recorded. In complete contrast to Al, Mg alloys seem to be immune to Fe contamination, possibly because of the presence of about 0.3% Mn in many Mg alloys; even with repeated fusions of the same charge in one steel crucible no increase in Fe content could be detected.

Closely connected with the problem of contamination during melting is the question of remelting, always a point of controversy. Al castings made from remelted material are generally considered inferior because of the large proportion (often over 50%) of foundry scrap present in the charge. M. HAJEK and J. KORITTA ("Influence of Repeated Remelting on the Properties of Light Alloys," *Foundry Trade J.,* Vol. 60, June 22, 1939, pp. 555-556) have studied this problem, using (1) an Al-Cu alloy, (2) an Al-Cu-Zn alloy, (3) an Al-Si-Cu alloy, and (4) an Al-Si-Mg alloy—all standard analyses. Starting with pure metals, the alloys were melted in Morgan coke-fired furnaces in graphite crucibles without fluxes and test pieces were cast and tested; intricate green-sand castings were also produced from each melt. Then broken test pieces, risers and experimental castings were added to the next melt; this whole procedure was carried out ten times with each alloy. Analyses showed that the composition of alloys 1, 3 and 4 remained practically constant throughout the remeltings. Alloy 2 lost about ½% of its Zn content after 10 meltings. Evidently alloy 4 lost Mg, because small quantities of Mg were added to each melt to keep the Mg content between 0.2 and 0.3%. The tests showed that repeated melting has no harmful effect on the quality of the 4 Al alloys tested. Therefore, the inferiority of remelted material often experienced must be attributed to the use of scrap material of unknown composition or to a lack of care during melting, rather than to the remelting itself.

Melting temperatures and type of furnace are also important factors. Murphy, Wells and Payne warn that the physical properties of Al alloy castings are adversely affected if the molten metal is raised to too high a temperature; the latter should be just high enough to give a reasonable speed of working. With the normal Mg alloys, however, superheating is decidedly advantageous and is, for example, an essential factor in the furnace treatment of Elektron alloys. Best properties are obtained if the temperature of the metal, just before casting, is raised to 850-900° C.; the casting temperature, however, is independent of the superheating and should be suitably adjusted before pouring. A new furnace, said to offer advantages of greater efficiency and safety in melting Al alloys has been developed by W. HEILIGENSTAEDT ("Der ferngasbeheizte Leichtmetall-Schmelzofen mit Strahlheizrohr," *Z. Metallkunde,* Vol. 31, June, 1939, pp. 209-212). The furnace is indirectly heated by radiant tubes of heat resistant steel in which cheap gases are burnt. The advantages in comparison with ceramic combustion muffles are said to be: (1) No leakages; (2) greater efficiency, because of better heat conductivity of steel, (3) safer operation, due to easy shut-down of individual tubes and their replacement. The combustion and tube temperatures respectively are 1750° and 900° C.; the heater tubes are protected against splashed Al by an enclosing steel tube. Furnaces of 300-10,000 lbs. bath capacity and an hourly output of 100-1,000 lbs. are in operation. X (3b)



Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER

AND H. W. GRAHAM,

SECTION EDITORS

Microscopic Investigation of Structural Changes during Plastic Deformation (Mikroscopische Untersuchung der Gefügeumwandlungen bei plastischer Metallverformung) PAUL DUWEZ. *Arcos Z.,* Vol. 16, June 1939, pp. 1969-1978. Original research. A method of microscopically studying the structural changes of metals under tension is described. Small tensile specimens of extra-soft normalized steel, polished and etched, are observed under the microscope while the specimen is subjected to increasing tensile stresses. Thus the origin of the gliding planes and their change during gradual increase of tension could be studied. For a certain elongation only part of the grains show slip planes, increasing with increasing deformation. To determine the strain corresponding to beginning of slip, the ratio of grains with slip planes to the total number of grains visible in the field of observation was calculated for different values of elongation. With pure Fe, the first slip planes were observed at about 5% elongation, *i.e.* after the yield point had been surpassed considerably. In plotting the above-mentioned ratio against the elongation the curve shows a point of inversion, *i.e.* at a certain elongation the velocity of growth of the slip planes as a function of the elongation reaches a maximum. The values of elongation corresponding to the point of inversion of different materials seem to be characteristic of the course of plastic deformation. The possibilities of application of this interesting new method of research are said to be far-reaching. It permits determination or study of (1) the starting point of a plastic deformation, while other methods make possible only determination of stress peaks, (2) the effect of the type of disturbance causing local excessive stresses, (3) the more or less pronounced equalizing capacity of metals, decreasing local stress peaks by plastic adjustment, and (4) structural disturbances in welds in relation to the mechanical properties of welded joints. GN (D-4)

Cutting Tools. The problem of what cutting tool to use for a given metal is complicated not only by the number of cutting tools available and the vast number of metals to be machined in general, but by technical factors such as the quality of the surface finish and economic factors such as tool life, speed of cutting, type of lubricant, etc. Three recent articles on cutting tools cover among them a broad range of materials to be cut and cutting materials.

H. SCHALLBROCH & R. WALLICHS (Werkzeugverschleiss, insbesondere an Drehmeisseln." *Ber. betriebswissenschaft. Arbeiten,* No. 11, 1939, 35 pp.) discuss the wear of turning tools made of high speed and high alloy tool steels as applied to the machining of low alloy steel, cast iron and an aluminum alloy. After considering first the general principles underlying wear, the authors established uniform rules, measuring units and clear

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definitions of tool wear. The importance of chemical composition, structure, hardness, toughness and surface condition as affecting tool wear is pointed out. The effects of tool wear on cutting power, cutting temperature, rate of machining, surface quality and stand-up time were investigated by experiments in which, for a definite width of wear, the stand-up time was determined.

The square of the "width of wear" increases in a straight line with the amount cut or with the cutting time. In carrying on such experiments on steel St. 80 (0.45% C, 0.32 Si, 0.71 Mn, 0.01 P, 0.3 Mo, 0.91 Ni and 0.23 Cr) cast iron Ge 22 (2.77% C, 1.48 Si and 0.66 Mn) and an Al-base alloy (1.23% Si, 2.17 Fe and 3.21 Cu), an absolutely different wear effect from these 3 materials resulted. The curve obtained by plotting cutting speed against stand-up time possesses approximately the same slope for the cast iron and light metal, whereas the curve for St. 80 had a much steeper slope, indicating heat effects besides wear in the last case. In also applying various types of tool materials (different hard metal alloys, high speed steels and tool steels) a clear sequence as regards wear resistance could be established. The Co-free, high-V high speed steel is superior to the 10%-Co high speed steel at small cutting speeds, *i.e.* the Co-free steel is qualified to thread making and similar work, where wear should be small.

H. H. Beeny ("Cutting Tools for Cast Iron," *Foundry Trade J.*, Vol. 60, June 29, 1939, pp. 571-572, 574) stresses the value of sintered carbide tools for cutting cast iron. In good-quality irons the combined carbon is in the region of 0.70-0.80%, so that the matrix is pearlitic and corresponds to the composition and structure found in a high-carbon steel. The important influence of combined carbon applies not only to ferritic and pearlitic gray irons, but extends to mottled and white castings, where the constituent appears in the massive as well as in the pearlitic form. Cutting speeds are much reduced but with a suitable grade of sintered carbide tool, white cast iron possessing a Brinell hardness of 415 can now be successfully turned, at a cutting speed of about 25 ft./min. Even alloy white cast irons containing Ni and Cr, in which the combined carbon that would normally be pearlitic is retained as hard martensite, can be machined with these tools at from 10 to 15 ft./min. as an extreme case, although the Brinell hardness of the metal may be as high as 555. This contrasts with a turning speed of from 200 to 500 ft./min. for an average unannealed gray iron of about 200 Brinell.

The sintered carbides possess a tensile strength of about 140,000 lbs./in.^{2}, which is said to be fully equal to the figure for Stellite, but is only half that of hardened high-speed steels. The cold hardness, however, which ranges from 1,320 to 1,545 Vickers pyramid hardness numbers, is much superior to that of either rival. Even more striking is the fact that at a dull red heat (600° C.) the hardness is still much greater than the cold hardness of the other materials. Tungsten carbide, which is believed to have the best all-round properties, is described as the universal choice for machining cast iron. With tungsten carbide tools the cutting speeds are from 3 to 5 times greater than with the best high-speed steels and the abrasive action of sand and scale is much better resisted than with high-speed steel.

Further data on the applicability of hard carbide as compared with high speed tools, this time for cutting light metals, are given in another very recent article ("Modern Practice in Machining Light Metals," *Light Metals*, Vol. 2, Aug. 1939, pp. 265-270). Magnesium alloys do not ordinarily require the use of the newer, hard-carbide tool materials. In the case of Al alloys, the ratio of speeds that can be used with carbide tools compared with that allowable for high speed tools (for the same wear) is 19/4.7. Certain changes in tool design are necessary when using the carbides owing to their greater brittleness. Thus the tool point is usually made with a larger radius of curvature to distribute the load over a greater area. The diamond-tipped tool is reserved almost exclusively for finishing operations. Tool shapes for cutting Mg alloys are different than those for Al alloys; the rake angle is reduced, and the clearance angle is increased. The feed for Mg alloys should not be below 0.08 in./rev. except when machining at very high speeds. X (G-4)

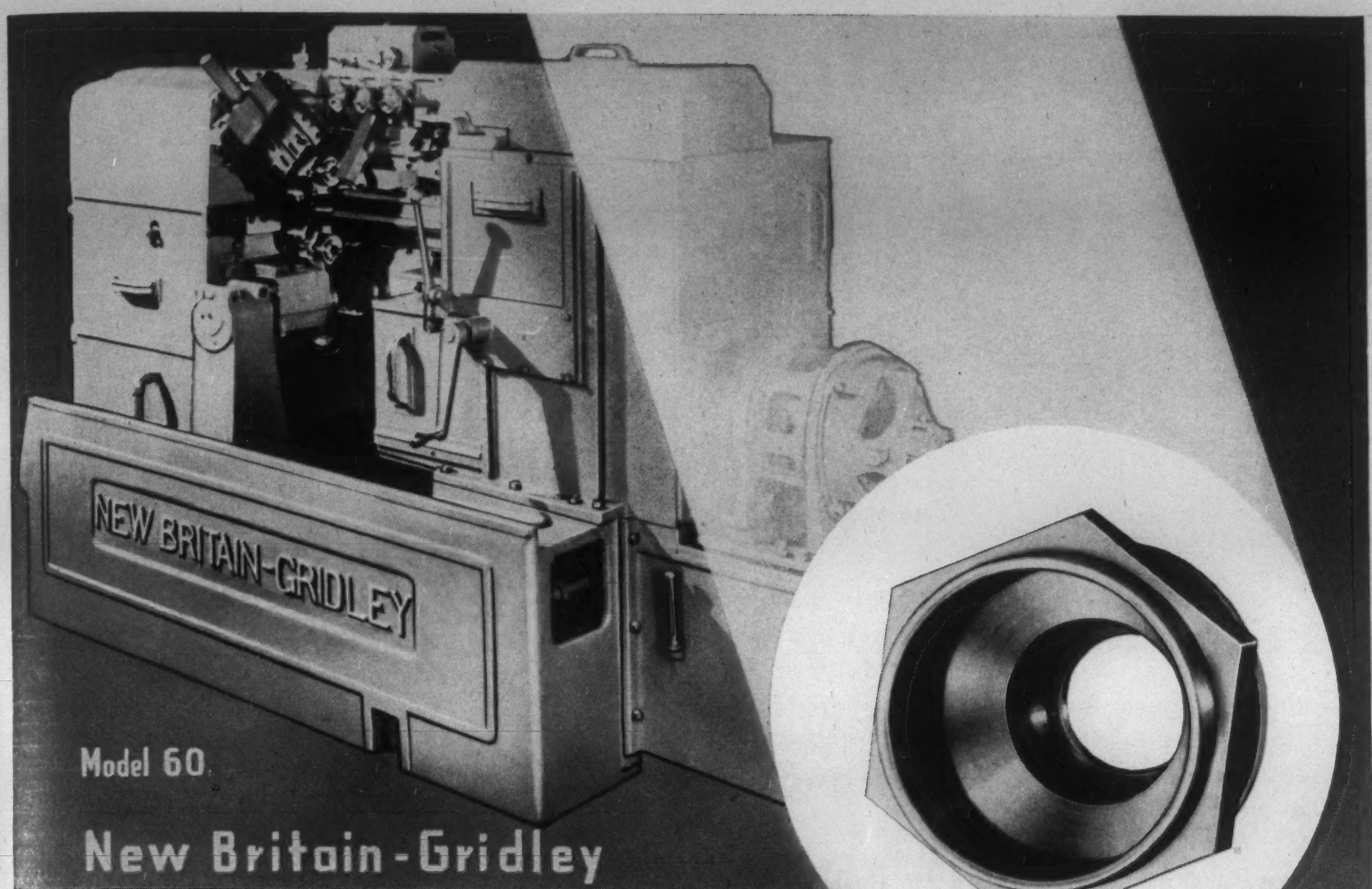
4a. Ferrous

Stretcher-Strain Markings in Low Carbon Steel. J. D. Jevons. *Iron Steel*, Vol. 12, July 1939, pp. 629-635. Review. The "yield-work harden-yield elsewhere" or "lag" in plastic deformation theory is discussed clearly. Since pure ferrite and medium-C steels do not exhibit stretcher strain markings, a definite range of C content must be postulated if the theory is to hold. The theory also fails to explain clearly why light cold working entirely eliminates yield point elongation and why it returns after a period of time. The influence of Fe_3C is discussed in the light of the possible effect of a keying action. A second theory is based on the (110), (112) and (113) planes with their corresponding 48 possible directions of slip. As a result there exists a large number of favorably oriented planes which would slip easily, resulting in a large yield-point elongation before work hardening enough to induce slip in less favorably oriented planes. This results in the horizontal part of the stress-strain curve that indicates the yield-point elongation, which may thus serve as a direct criterion of the tendency to form markings. A third, so-called "honeycomb," theory is based on the ferrite crystals being surrounded by Fe_3C envelopes. The upper yield point is where the envelope breaks down and throws the whole strain on the ferrite crystal, the stress falls to the lower yield point and the crystal then work hardens.

Points pro and con are clearly discussed for all the theories designed to account for distortion wedges. Markings increase in severity and yield point elongation increases as crystal size becomes larger, but advantage cannot be taken of this since a grain size selected must be compatible with good finish on the product, finer grain being best. Directional properties in steel sheet influence the pattern of markings. Non-aging steel is discussed as making the effects of temper rolling more permanent. Roller leveling as often applied just prior to rolling is not nearly as effective or permanent as temper rolling, but if employed, allows greater latitude in the purchase and use of sheet.

Five ways in which the consumer can combat distortion wedges are: (1) By using sheet as soon as possible after being temper-rolled by supplier; (2) by carefully roller-leveling sheet in his own shop immediately before pressing; (3) by proper design, and choice of suitable stages of forming; (4) by reducing speed of pressing; and (5) by cooperating closely with the supplier. HFT (D-4a)

The Resistance of High-Silicon Malleable Iron to Drilling. H. A. Schwartz, R. C. Kasper & N. E. Mertz. *Preprint Am. Soc. Testing Materials*, June 1939, 2 pp. Research. The machinability by drilling of malleable cast iron ranging from 2.09 to 2.36% C and from 1.39 to 2.10% Si was determined in the Olsen Efficiency Machine. Both C and Si improve the machinability of malleable iron as measured by the rate of penetration of a standard drill, or as measured by the torque on a drill running with a predetermined advance per revolution. Silicon is about twice as effective as C in reducing the torque, and C is almost as effective as Si in reducing the number of revolutions required to penetrate 1 in. at standard load. The results with regard to torque are less affected by unknown variables existing between different heats than the results regarding penetration. VVK (G-4a)



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Factors Governing Selection of Weld Grinding Equipment. R. M. GASTON (Gaston Power Tools) *Welding Engr.*, Vol. 24, June 1939, pp. 28-29. Practical. Grinding is the hardest work required of any portable tool. Grinding may require continuous high speed and high power for hours in a stretch. Free-hand grinding can often use up to 3 h.p., but usually 1 or 2 h.p. is sufficient. Grinding is fundamentally a high speed operation as the wheels cut better at high speed and wear much longer. Hence grinding should be done at the highest speed which is safe for the wheel. When grinders use regular electric power the grinding department can be started with a small investment for one machine. While most grinding must be done with edge cutting wheels, they have several faults. Cup and disc-type grinding wheels will make a flat surface smooth more quickly than any other type and in many cases one pass will produce the final finish required. A wheel must be kept true and balanced to do its fair share of work. Different types of work require grinding wheels of different specifications. If a wheel glazes and cuts too slowly the operator should try a softer grade. If a wheel wears too fast it may be possible to use a harder grade without trouble. One lb. of abrasive material should under proper conditions remove about 10 lbs. of soft steel. CEJ (G-4a)

4b. Non-Ferrous

Drawing Tools for the Working of Light Metals (Ziehwerkzeuge für das spanlose Formen von Leichtmetallen) E. J. RITTER. *Maschinenbau Betrieb,* Vol. 18, July 1939, pp. 335-338. Practical. Dies for drawing light metal parts are made of steel, cast iron, zinc alloys and Mg-Al alloy. Stripping dies are made from steel plates, and occasionally from castings. The punches are made from wood, plastics or metal. Combined stripping and coining dies have a bottom part made of metal, xylolite or hard wood. In airplane manufacture with relatively small quantities wooden tools are often economical. A few hundred parts can be drawn in such tools. If durability during storage is desired drawing tools can be made from hard wood compounded with a synthetic resin. 600-1000 parts can be drawn in such material without repairing the tool, and savings are also effected in material and machining cost. Rubber punches can be used, but these must be framed in steel. For deep drawing Mg-Al alloy sheets, the dies are preheated to 350° C., and drawing is carried out at 300° C. The speed of draw should not exceed 2mm./sec. Good lubrication on the holding clamps is, of course, essential. For Al, the lubricant may be graphite powder with kerosene, castor oil or tallow; for other light metals kerosene-bearing mineral grease is used for the first operation, emulsified light machine oil for the following operations. "Muzin," an animal mucilage product is used successfully. The various tool materials with properties, machining operations, material costs, application, etc. are assembled in charts. RPS (D-4b)

Investigation of the Flow Processes in Singly and Multiple Extruded Light Metal Rods (Untersuchung der Fliessvorgänge im ein- und mehrstranggepressten Leichtmetall-Stangenmaterial) H. WALBERT. *Aluminium*, Vol. 21, July 1939, pp. 505-509. Research. Structural phenomena during extrusion of light metals, using an Al alloy with 4% Cu, 0.9 Mg, 0.35 Si and 0.8 Mn, are described; blanks of this material were extruded at a speed of 0.015 m./sec. under a pressure of 1700 tons and a temperature of the metal (in the holder) of 350° C. Etched sections of the region where the plunger strikes the blank show clearly the flow lines and structure. The general conclusion is that the pressing process alone determines the type of structure developed in both single and multiple extrusion; the fine- and coarse-grained zones are formed by friction and the pressure on the material in the holder before passing through the die or nozzles. Passage through the die produces zones of characteristic appearance for single and multiple extrusion. Pressure and temperature determine the extension of the zones of fine and coarse grains. The fine or coarse-grained zones seem to have no effect on the mechanical properties of the extruded materials. Ha (D-4b)

Extruded Lead Casings for Condensers. G. R. GOHN. *Bell Labs. Record,* Vol. 17, May 1939, pp. 277-280. Descriptive. Development of extrusion of soft metal tubes in forms other than round. Previously, condenser cans were made by folding and soldering seams. Shaped Pb blank having the same cross section as the finished product is placed in the cavity of the die and extruded by an impact operation with a punch of the same shape as the die but smaller to allow for the thickness of the walls of the can. A pressure of about 40,000-60,000 lbs./in.^{2} at room temperature is required. There is a small poppet valve in the bottom of the punch to admit air, which aids mechanical fingers in removing extruded can from punch. Mechanical presses are preferred to hydraulic as they have higher operating speed and give greater output. JZB (D-4b)

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O. E. HARDER and H. DREVER
SECTION EDITORS

Selection and Testing of Cupola Refractories. W. J. REES. *Foundry Trade J.*, Vol. 61, July 27, 1939, pp. 63-66, 68. Review. Cupolas are in general lined in one of the three following ways: (1) With firebrick, (2) with brick or blocks cut to shape from a natural siliceous rock or "firestone" and (3) with a plastic or semi-plastic material having either a silica or burned fireclay base, rammed around one of the first two. From the chemical standpoint aluminous firebricks are likely to be advantageous. Cupola bricks and blocks should be of low porosity, hard fired and clean-burned, and should contain no segregations of uncombined iron oxide, as these lead to carbon deposition and consequent weakening or disintegration of the bricks from the catalytic dissociation of CO. Some attention should also be given to the mechanical strength of the firebrick at the working temperature. It is likely that the high-temperature "creep" tests now being made will provide information that can be applied to the selection of cupola firebrick. Silica firestone blocks or bricks are not extensively used in British foundry practice, but their use in American foundries is being followed with interest. The plastic or semi-plastic materials are usually highly siliceous, although a few iron founders use mixtures containing a high proportion of fireclay grog with a bond of plastic fireclay.

The siliceous mixtures used for the production of rammed linings and for patching are of 2 types: (a) natural silica "clays," which consist of sand grains in small size uniformly coated with a highly plastic siliceous clay; and (b) silica rocks of "ganister" type, which are crushed and ground with a plastic fireclay. In mixtures containing between 7 and 10% of alumina (20 to 30% of an average 30% alumina fireclay) there is a rapid fall in the fusion point; the presence of fluxing impurities in the silica rock and fireclay move the lowest fusion point in the direction of a lower silica-alumina ratio. The patching materials are made by mixing a crushed silica rock containing not less than 92% silica with from 10 to 30% of a refractory plastic fireclay, the proportion of clay used depending on the character of the silica rock, the chemical composition and plasticity of the clay, and the required plasticity of the mixture. The physical character of the silica rock should be such that when it is crushed it will give angular fragments. Rounded fragments tend to slip over each other, and so lead to weakness, while angular fragments tend to interlock, and so promote strength. Properties of cupola lining materials, mechanical grading of patching materials, influence of moisture, refractoriness, slag resistance, refractoriness under load, etc., are discussed. AIK (5)

5a. Ferrous

Surface-hardening and Hard-surfacing. C. E. MACQUIGG (Ohio State Univ.) *Mining and Met.*, Vol. 20, Apr. 1939, pp. 189-194; *Welding J., N. Y.*, Vol. 18, June 1939, pp. 341-348. General survey of the metallurgical, economic and practical aspects of the various processes. Proper control of surface-hardening is essential and it may be done by: (1) Varying the composition during heat treatment; (2) treatment by heat without varying the composition; and (3) cold working. The factors to be considered in selecting a hardening process are cost, convenience and serviceability.

From the metallurgical point of view, flame-hardening and induction-hardening have an advantage over case-hardening in that no change of chemical composition takes place in the hardened surface. In flame-hardening, only the superficial layer of metal is heated to hardening temperature, and additional quenching action is derived from the relatively cold mass of metal lying below the heated surface. This underlying metal subtracts heat from the superficial layers and produces a more drastic quenching action than would result from a liquid quench. Good case characteristics are obtained because there is no transformation; the stresses between hard surface and relatively ductile core are low, which makes for freedom from spalling. Surface hardness, depth of hardness and case may be varied by composition of steel used, time and rate of heating, and quenching practice. Because parts are quickly raised to critical point, and promptly quenched, flame-hardened parts are scale-free. The applications of the process are considered, and a useful table is given for the selection of proper flame-hardening steels. In practice, flame-hardening may be stationary (sometimes called spot-hardening), progressive, or spinning. Hardening should be followed by low temperature draw to relieve quenching stresses. However, the process may be made self-drawing if the quantity and application of the quenching medium are controlled.

Hard-surfacing consists of welding on to the wearing part a facing, edge or point of hard metal resistant to abrasion. Hard-surfacing alloys are divided into: (1) Low-alloy steels; (2) high-alloy steels; (3) non-ferrous alloys; and (4) tungsten carbides and borides. In the selection of the correct facing material, it is necessary to determine the dominant factor causing deterioration of the part. Selection of the proper group is based on the best combination of properties, cold hardness, red hardness, impact resistance, corrosion resistance, deposit smoothness, ability to scour and thinness of welding. The chief attributes of the alloys used are tabulated. Information on methods of procedure and on various applications of the process is included. VSP + WB (5a)

Malleableizing in Short Cycles. T. L. ROSS. *Automotive Ind.*, Vol. 80, Apr. 15, 1939, pp. 496-499. Descriptive. Malleableizing cycles have been reduced in the past decade from 200 hrs. to less than 55 hrs. by means of controlled atmosphere furnaces. Based on older production methods, charges packed in scale-filled pots placed in box-type kilns were brought up to 1550° F. in 40 hrs. This treatment was followed by a soaking period of 60 hrs. prior to cooling down to 1200° F. in 85 hrs. From then on, the cooling rate was increased by opening the furnace, and at 600° F. the charge was unpacked. This cycle could be considerably shortened if it were possible to eliminate time at ineffective temperatures, such as the heating-up period. Likewise, it would help to take advantage of increased speed of graphitization for short periods at temperatures that would be detrimental to grain size for longer periods. This is obviously impossible, owing to the large tare used in the operation. With the elimination of this tare in the newer continuous controlled atmosphere furnaces, the material is heated quickly to 1500° F., then heated slowly to 1700° F. and held for 10 hrs. This treatment is followed by a rapid cool to 1400° F. and discharged after a slow cool to 1300° F. Only 36 hrs. is required for this cycle. Many types of furnaces and methods of operation are discussed. CMH (5a)

The Hardening on Tempering of Austenitic Chromium-Nickel Steels Containing Boron (Die Härtung borhaltiger austenitischer Chrom-Nickel-Stähle beim Anlassen) H. CORNELIUS. *Arch., Eisenhüttenw.*, Vol. 12, Apr. 1939, pp. 499-505. Original research. A series of austenitic Cr-Ni stainless steels containing from 0.04 to 0.33% C, 16 to 32% Cr, 6 to 30% Ni, and 0.8 to 1.7% B, were studied. Specimens were water-quenched from 1200° C., tempered at 500° to 900° C. and the changes in hardness and microstructure observed. Dilatometric tests were also made. The higher-C alloys showed hardening upon reheating to 600° to 800° C., the hardness increase being as much as 40%. A precipitated phase was noted, which was believed to be a boride-carbide solid solution. It is stated that through the formation of this phase the austenite tends to become impoverished of the elements that stabilize it, so that the austenite partly breaks down to martensite. The hardening that occurred was largely attributed to this martensite formation. SE (5a)

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Hardness Problems in High Speed and High Alloy Tool Steels. KAROL ROSNER. *Iron Steel,* Vol. 12, July 1939, pp. 616-620. Research. The study was made to determine whether the hardness of a steel tool at the elevated temperature of operation was a simple function of room temperature hardness, or whether other factors (such as heat treatment) were predominant. Steels studied were (1) 12%-Co high speed, (2) 18/4/1 high speed, (3) high alloy tool steel with high Cr and low W, and (4) high Cr-high C tool steel. Hardness values were taken at temperatures from 20° to 525° C. after hardening several specimens to "primary" hardness (not tempered), and a duplicate series to "secondary" hardness (quenched and tempered). A specially made stage on a Vickers tester was used. The untempered specimens fell in hardness rapidly at 200° C. while those quenched and tempered held their hardness well to 525° C., the greatest difference being noted at 300° C., the approximate maximum temperature ordinarily reached by milling cutters, broaches, etc. The indicated higher hardness leads to the conclusion that high-temperature tempering is indispensable, except for the Co steel, which maintained relatively high hardness in either case. Much advantage is gained by "aging" both high speed and high alloy tool steels, the advantage often being neglected in the latter case. The formation of a soft "guiding skin" should be prevented as this causes failure of many tools otherwise satisfactory.

An 18/4/1 steel was selected and specimens were (1) properly tempered to maximum hardness, (2) under-aged, and (3) over-aged to determine if a higher hardness at room temperature always meant a higher hardness at elevated temperatures. Hard-tempered samples were hardest at all temperatures up to 500° C., but the hardness at room temperature is not representative of that at higher temperatures in 18/4/1 steel, this being influenced more by heat treating procedure. Tools heat treated to reach maximum hardness by repeated short time tempering give better performance than if prepared in the usual manner of a single longer time tempering. Too long or too short tempering times, over- or under-aging, result in lower hot hardness in spite of apparently satisfactory hardness at room temperature. [For an American research on this subject see *Metals and Alloys,* Vol. 4, Dec. 1933, p. MA 400 R/4. —O.E.H.] HFT (5a)

Kinetics of the Growth of Austenite Grains in Cast and Forged Steel Containing Additions of Aluminum, Vanadium, and Titanium. K. A. MALYSHEV. *Metallurg,* Vol. 14, June 1939, pp. 30-47. In Russian. Research. The kinetics of the growth of austenite grains was investigated at a heating speed of 160°-180°/hr. Each heat was characterized by a certain period of stability of the fine-grained austenite system (incubation period of grain growth at a given temperature) above the critical range. The period of austenite grain growth, which starts after the incubation period, produces non-uniformity of grain size. Small additions of Al, V, and Ti prolong the incubation period and raise the temperature of initial austenite grain growth by 100°-150° C. in comparison with ordinary steel. Cast steel showed the greatest stability of fine austenite grains. Energetic forging reduces the incubation period and lowers the temperature of initial grain growth by 50°-100° C. in comparison with cast steel. Addition of 0.05% and 0.1% Al enabled retention of fine grain up to 950°-1000° C. Addition of 0.1% Ti maintained fine grain up to 1000°-1050° C. in the cast condition, but after forging the stability of the fine-grain condition did not differ from ordinary steel. Steel containing 0.23% V differed from all the others in that this addition permitted retention of fine grain even under the influence of forging and heat treatment; the fine-grain condition was retained up to 900°-950° C. and no noticeable differences in grain size were observed up to 1200° C. Preliminary heat treatment greatly affected the stability of the fine grained austenite. Repeated heatings in the interval 850°-1000° C. decreased the stability of the fine grained austenite in both ordinary and in Al-containing steels, but preliminary high overheating (1100°-1200° C.) increased the stability of fine grained austenite in the Al-containing steels. BZK (5a)

Transformation of Austenite on Quenching High-purity Iron-carbon Alloys. THOMAS G. DIGGES. *J. Research, Natl. Bur. Standards,* Vol. 23, July 1939, pp. 151-162. Original research. Primarily shows the influence of variation of distribution and solution of C in austenite on the mode and rate of transformation of austenite in high-purity Fe-C alloys. The transformation of a nonuniform grain of austenite often proceeds at various rates in different regions within the grain, and its initial transformation to troostite is not always confined solely to its grain boundaries. These facts are illustrated by a representative case in which an individual grain of austenite transformed to cementite, ferrite, lamellar pearlite, nodular troostite, and martensite. The results of microhardness tests made on the decomposition products of this same grain of austenite, the influence of grain size on the transformation rate of austenite, and the occurrence of cracks in quenched specimens of the hypereutectoid alloys are also discussed. WAT (5a)

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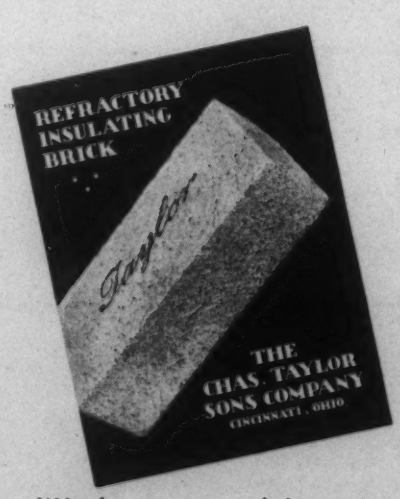

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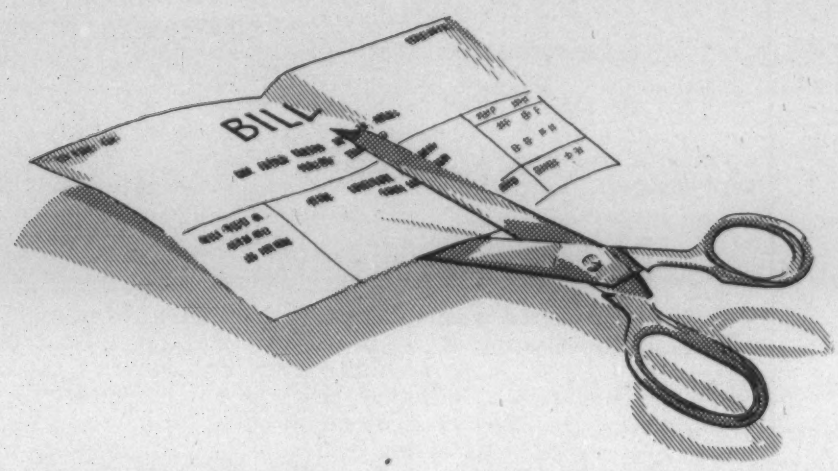

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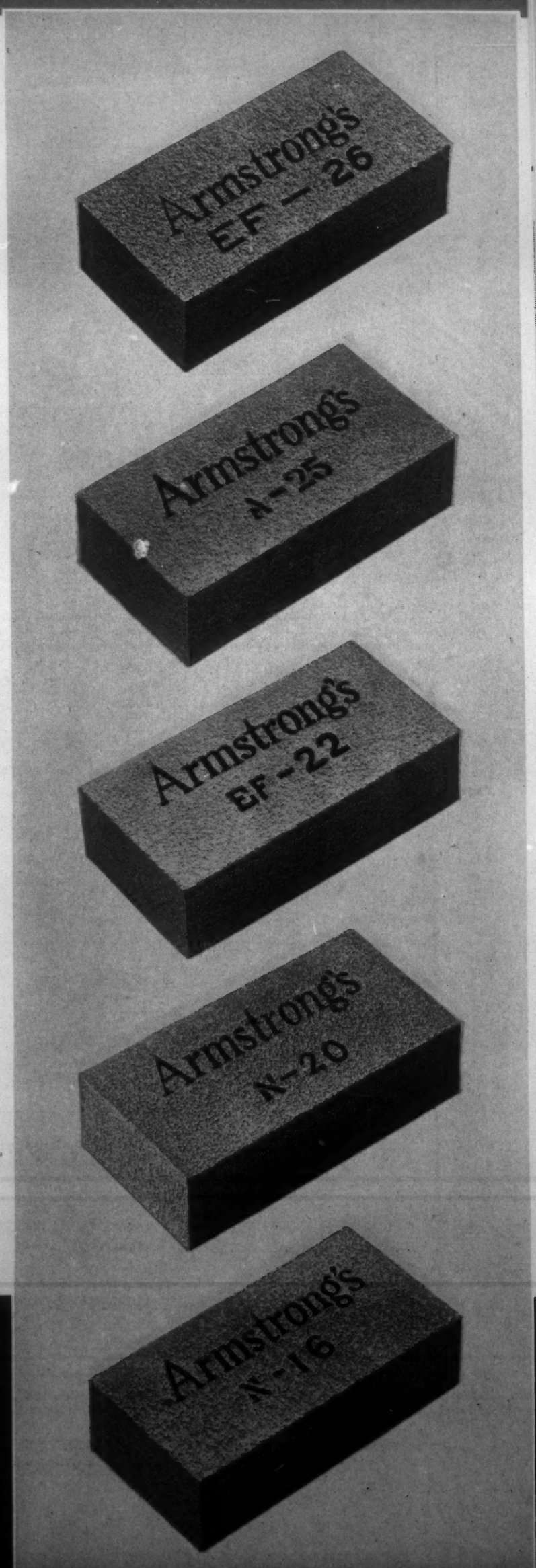

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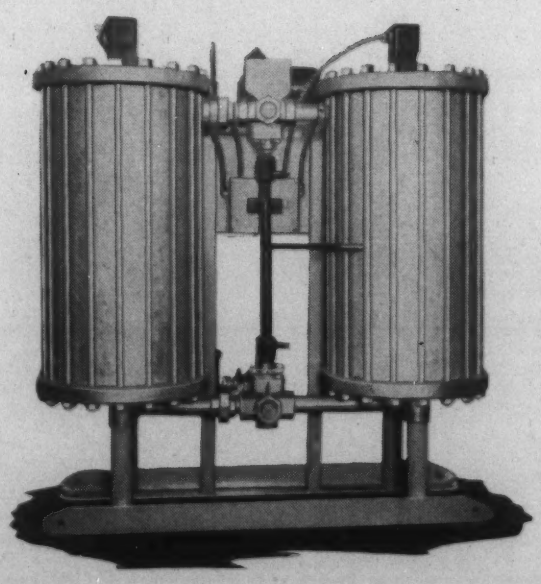

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The Mechanism of the Reaction Between Hydrogen and Carbon in Iron. W. BAUKLOH & B. KNAPP. *Iron Steel Inst., Carnegie Schol. Mem.*, Vol. 27, 1938, pp. 149-164. Research. Decarburization with hydrogen occurs as a result of the reaction $Fe_3C + 2H_2 \rightleftharpoons 3Fe + CH_4$. Hydrogen dissolves out C from surface cementite or from γ solid solution. Iron produced at the surface interferes with the access of H_2 to C and compels it to diffuse. If diffusion of C is slower than the reaction, diffusion governs the rate of decarburization. Above 850° C. the rate of diffusion of C is greater than that of the reaction, so that the latter then controls the rate of decarburization. The authors distinguish between 3 boundary zones as follows: (1) Pure ferrite layers existing below the GOSK line of the Fe-C diagram. (2) Transition boundary layers (existing between GOSK line and about 850° C.) in which the C content diminishes outwards and (3) hypereutectoid boundary layers, which exist above 850° C. and in the region of austenite and cementite. To explain his results reference is given to the Fe-C-H system and to rates of diffusion of C in Fe. [The authors' tacit assumption that Fe_3C is stable at temperatures of his studies is incorrect. The interpretation of their results also seems to be open to question.—C.W.] 12 references. CW (5a)

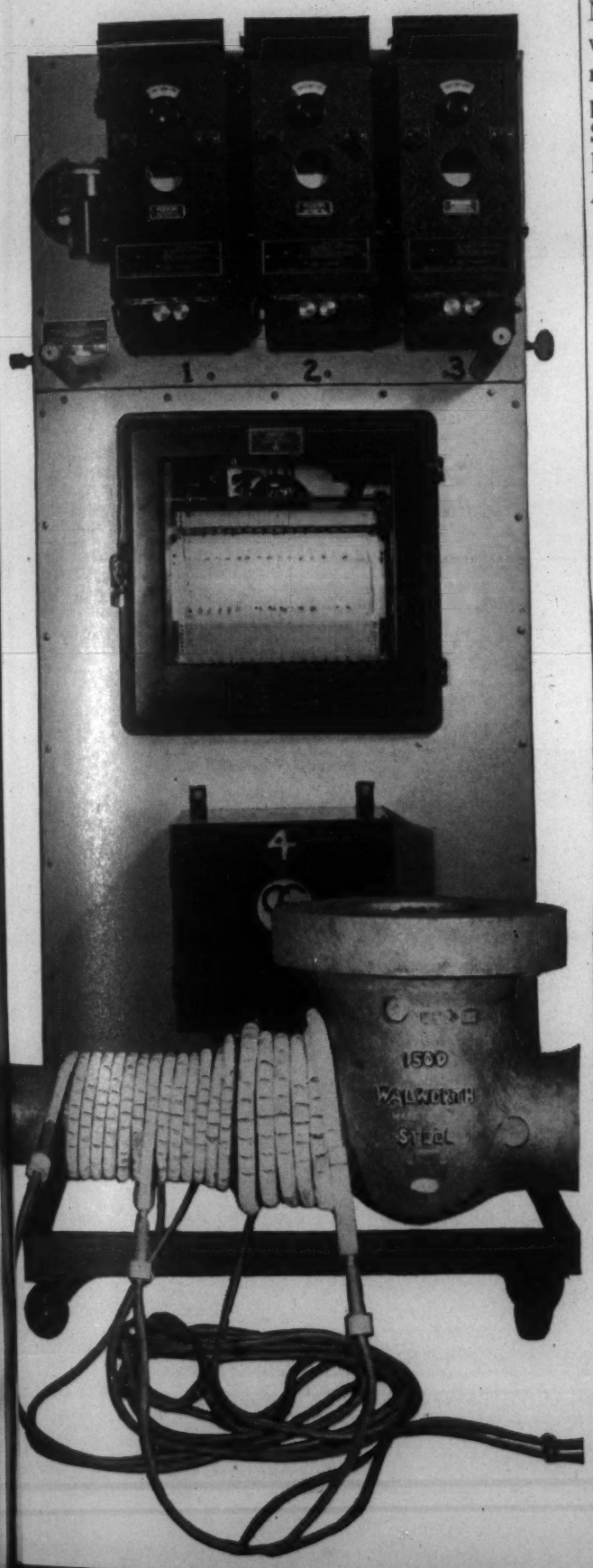
5b. Non-Ferrous

Age-Hardening of Aluminum Alloys. Recent articles on the heat treatment of Al-base alloys have come from all over the world, and have been concerned with several somewhat interrelated factors, including the type of equipment that should be used, the effect of composition on aging behavior, and the effect of modifications of age-hardening practice on properties, as well as with the theory of age-hardening. R. IRMANN ("Solution Heat Treatment of Aluminium Casting Alloys," *Foundry Trade J.*, Vol. 60, June 15, 1939, pp. 531-535) discusses some pertinent considerations in carrying out the high temperature treatment prior to quenching and precipitation hardening. The temperatures necessary for the solution treatment of casting alloys are very close to the solidus, and, therefore, should be held uniformly within ± 5° C. Likewise, the temperature for the subsequent precipitation treatment should be accurate to within ± 3° C. If, therefore, a maximum solution annealing temperature of 500° C. is necessary, the furnace should be set at 495±5° C., and this temperature must be evenly maintained in all parts of the furnace. Only electrically-heated furnaces with air circulation and automatic heat control are claimed to satisfy these requirements. Air circulation is essential in any case, because the rate of heating would be 2 or 3 times slower without it. Two pit furnaces separated by the quenching tank may be used—one furnace for solution treatment and the other for the precipitation hardening. The mechanical properties obtained are dependent on the rate of solidification within the casting as well as on the duration of the solution and precipitation heat treatments. The high mechanical properties obtained by heat treatment of Al alloy castings may be lost if the castings are exposed to elevated temperatures for too long a period. The heat treated Al alloys containing Cu, however, retain their mechanical properties in the face of excessively long heat treatment better than do most other Al alloys.

Specific data on the effects of Cu and Mg on the age-hardening of wrought Al-Cu-Mg-Mn alloys are provided by M. HANSEN and K. L. DREYER ("Ueber den Einfluss des Kupfer- und Magnesiumgehaltes auf die Aushärtung von Aluminium-Kupfer-Magnesium-Legierungen," *Z. Metallkunde*, Vol. 31, June 1939, pp. 204-207). The tensile strength in the as-quenched and aged (room temperature) condition increases considerably with rising Cu and Mg additions. Increasing the Mg content above certain concentrations affects the strength adversely; the optimum Mg content is lower the higher the Cu addition. The room temperature aging effect increases with rising Mg additions at low Mg concentrations but decreases at higher concentrations, until alloys with more than 4% Mg are reached, when susceptibility to precipitation hardening ceases. Raising the aging temperature accelerates precipitation hardening. All investigated alloys show distinct precipitation at 200° C. after short aging times. "Cold" precipitation hardening occurs in alloys with 1% and 2% Cu and over 2% Mg at temperatures up to 150° C., even during long aging times. The cold-aging of commercial duralumin has been singled out for special attention by K. L. DREYER ("Ueber die Rückbildung der Kaltaushärtung von Duralumin" *Z. Metallkunde*, Vol. 31, May 1939, pp. 147-150). Hardness measurements showed that the effects of room temperature aging could be obliterated rapidly by heating above 140° C., and the room temperature aging would then repeat itself. The time of low-temperature aging and the temperature at which it occurs, over a range from 20° to 100° C., had little influence on this release of hardness effect. However, cold work after room temperature aging diminished the amount of the hardness change on moderate reheating and also the extent of subsequent room temperature aging possible.

Similarly, the effects of an interposed cold-aging treatment on the hardness and tensile strength of Al-Mg-Si alloys heat treated

listen"



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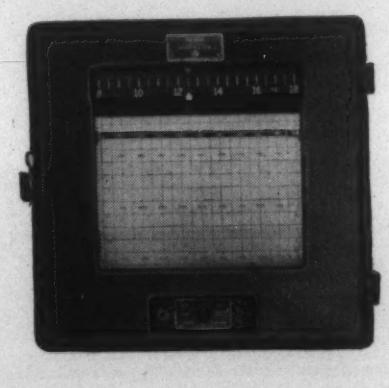

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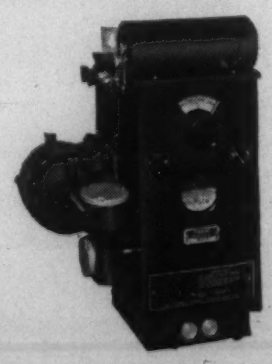

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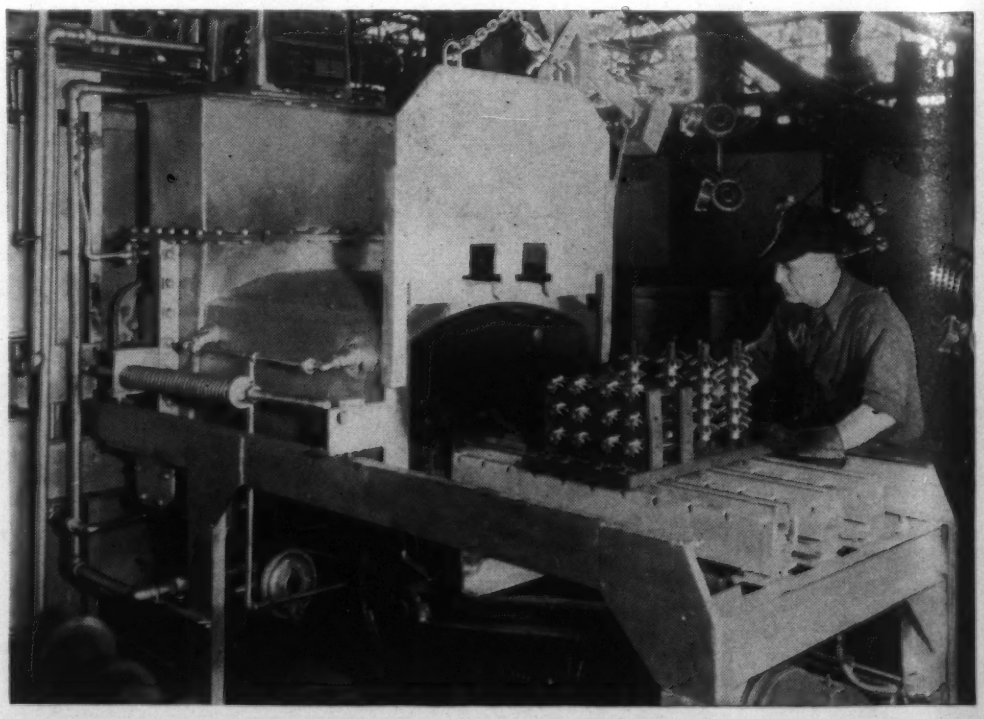

Charging a continuous gas carburizing furnace, Frost Gear & Forge Co., Jackson, Michigan
Photograph courtesy Surface Combustion Corporation.

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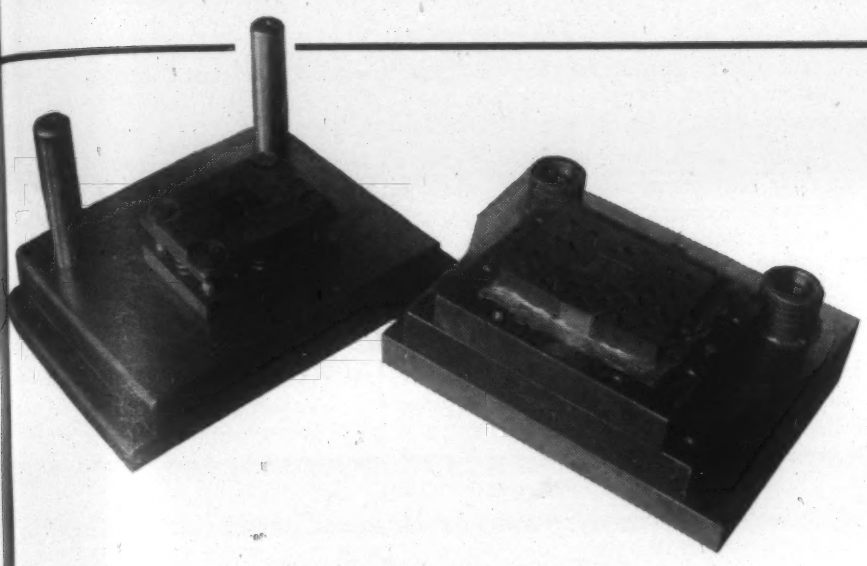

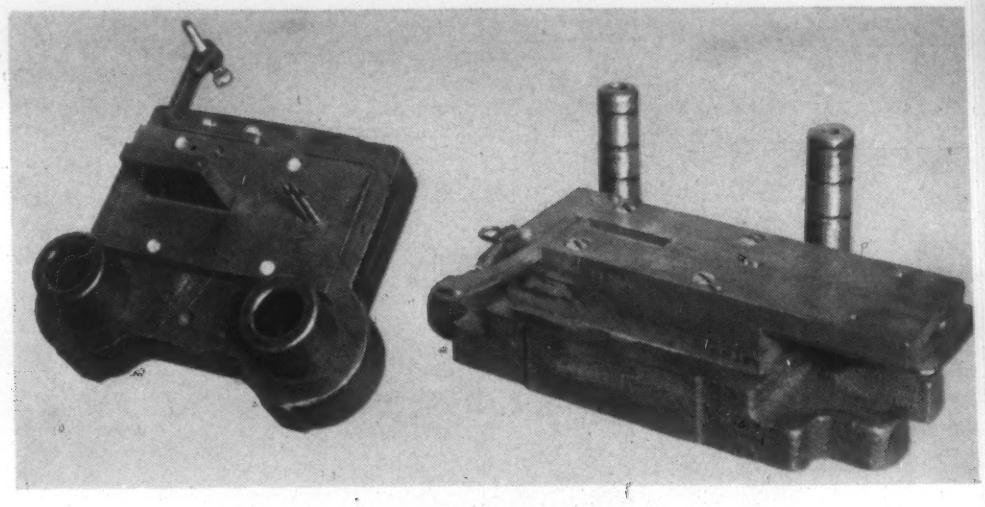

Expensive Grinding and Finishing Operations Eliminated

It has always been an accepted fact that damage to die blocks during hardening can not be avoided. This is now an old idea. Damage *can* be avoided. Die blocks can be bright hardened without oxidation, decarburization, distortion or cracking. Dies can be produced without expensive grinding or finishing operations. Production costs can be reduced without any loss in precision or quality.

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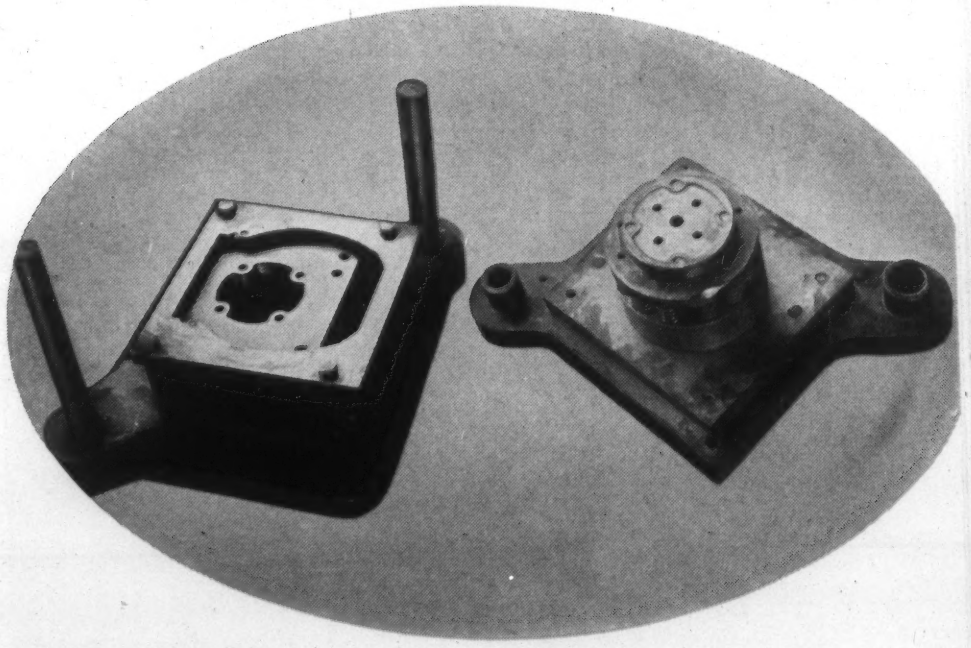

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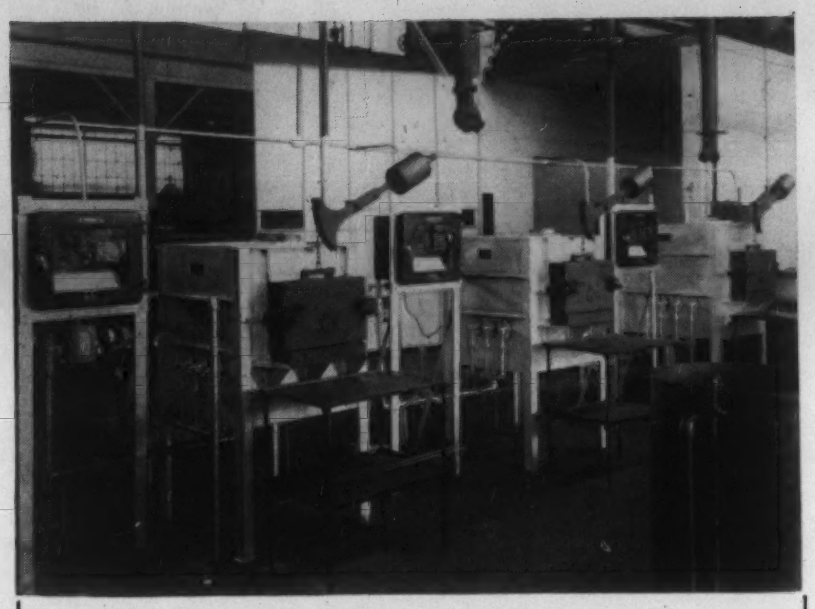

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at a high temperature were examined by B. BRENNER and H. KOSTRON ("Ueber die Vergütung der Aluminium-Magnesium-Silizium-Legierungen (Pantal)", *Z. Metallkunde,* Vol. 31, Apr. 1939, pp. 89-97). The maximum hardness obtained either at room temperature or higher temperatures is proportional to the amount of Mg_2Si present. Also, the hardness acquired by room temperature aging was not lost when a high temperature treatment followed, but greater hardness could be obtained without the intermediate room temperature treatment. This influence of room temperature aging on the maximum hardness obtainable could be eliminated either by small additions of Cu or by a short high temperature treatment before the room temperature aging. Using the same alloy, which incidentally contained 1.04% Mg, 0.80% Si, 0.84% Mn, and 0.35% Fe, P. BRENNER and W. FELDMAN ("Ueber den Einfluss der Wärmebehandlung auf des Korrosionsverhalten der Aluminium-Magnesium-Silizium-Legierungen (Pantal)", *Z. Metallkunde,* Vol. 31, Apr. 1939, pp. 97-101) determined the effect of heat treatment on corrosion resistance. The corrosion resistance was the greatest after aging at room temperature or in the fully annealed state, when attack was by pitting. Aging at higher temperatures diminished the corrosion resistance with increase in aging time. Corrosion after high temperature aging was of the intercrystalline type.

Clearly, such heat treating cycles as these leave the alloy in varying conditions of internal stress and, of course, with widely different mechanical properties, depending on the exact nature of the final treatments. Stress relief of Al alloy castings after any kind of otherwise final heat treatment is recommended by V. PREVER and M. BARBERO ("Tensione interne nei getti in leghe d'alluminio e trattamenti termici di stabilizzazione", *Ind. Meccan.,* Vol. 21, May 1939, pp. 357-359). The best thermal treatment is that which leaves a minimum of residual stress, without noticeably damaging the mechanical properties. Prolonged annealing below 200° C. was found to considerably lower residual stress without at all harming the mechanical properties of Al-Cu-Si-Fe, Al-Cu-Ni-Mg, Al-Si-Cu-Mg, Al-Si-Cu-Ni-Mg and Al-Si alloys.

The effect of time at precipitation-hardening temperature on the hardness of an Al alloy containing 11.8% Mg was studied by J. CALVET, A. GUINIER, P. JACQUET and A. SILBERSTEIN ("Étude du Revenu de la Solution Solide Aluminium-Magnésium," *Compt. Rend.,* Vol. 208, June 12, 1939, pp. 1903-1905). The alloy was heated to 435° C., water quenched and reheated at 200° C. for various time periods. The Brinell hardness before age-hardening was 87; after 1½ hrs. at 200° C., 97; after 2 hrs., 11; after 2½ hrs., 131, the maximum; and after 60 days, 102.

The *reason* age-hardening occurs in any case has yet to be established to everyone's satisfaction. G. SHINODA ("X-ray Studies on the Age-hardening of Super-duralumin," *Nippon Kinzoku Gakukai-Si* (in Japanese), Vol. 3, May 1939, pp. 211-215) followed with X-rays the age-hardening process in a 24 S type of alloy containing Si and Mn. In such an alloy, precipitation was observed at 150° C., although in the absence of Si and Mn many hrs. at 250° C. were required for attainment of "equilibrium." The addition of Mn or Si causes the precipitation of compound from super-saturated solid solution much easier but the degree of aging at room temperature is lowered considerably, and the type of aging changes to that of Al-Cu alloys. This latter type of age-hardening has been carefully studied by J. CALVET, P. JACQUET and A. GUINIER ("The Age-hardening of a Copper-aluminum Alloy of Very High Purity," *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 834, 17 pp.), using a 5.2% Cu alloy and hardening temperatures of 25°, 100°, 150°, 200°, 250° and 300° C. At the 2 higher temperatures, hardening, which is not very pronounced, is related to the precipitation of a new tetragonal phase. At low temperatures, hardening is more pronounced, but precipitation was slight, the first signs at 100° C. being visible only after 120 days. Mono-chromatic X-rays showed evidence of segregation of Cu atoms into minute plane layers, roughly 4 A.U. thick, 50-200 A.U. in length and breadth, and parallel to the cubic planes of the solid-solution crystals, but dispersed at random throughout them. At intermediate temperatures (150° and 200° C.), the 2 phenomena are superimposed; at first, the segregation of Cu atoms occurs, and later the tetragonal phase is precipitated.

Somewhat less complex than the explanation of the foregoing specific case are the conclusions on age-hardening of Al alloys in general, reached by W. L. FINK and D. W. SMITH after carefully correlating existing experimental data ("Age-hardening of Aluminum Alloys, IV. Discussion of the Theory," *Metals Tech.,* Vol. 6, June 1939, T. P. No. 1083, 13 pp.) According to them, age-hardening results from the controlled decomposition of a supersaturated solid solution. This decomposition is accomplished, as in other systems, by means of the formation of nuclei of a second phase and the growth of these precipitated particles. The nuclei form by the process of chance grouping of solute atoms, and Witmanstätten precipitation. Growth of the precipitated particles occurs by the usual process of crystal growth. The changes in physical and mechanical properties are explained in terms of this normal precipitation process. X (5b)

6 Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

E. V. DAVID, SECTION EDITOR

Welding in Marine Engineering Construction. H. N. PEMBERTON. *Welding Ind., London*, Vol. 7, May 1939, pp. 135-139; June 1939, pp. 179-182. Survey. The use of forge welding in the manufacture of important machinery forgings such as shafts, piston and connecting rods is not recommended. A forge weld has poor resistance to fatigue and should not be used where fatigue stresses are likely to occur in service. A blacksmith's forge weld should never be regarded as having more than half of the strength of a solid bar. The electrical resistance welding processes have been used more extensively in fields other than marine engineering. The future may see increased application of these processes in marine engineering. Resistance welded cable chains have been approved. Portable resistance machines are available only for light work, hence this process is mainly a shop operation. Gas cutting is of special interest in the preparation of parts such as plate edges for welding. In all cases it is recommended that the oxide film be removed by chipping and wire brushing before welding is begun.

In marine engineering construction work the question is not so much one of welding *vs.* riveting, as it is one of welding *vs.* casting. The substitution of mild steel welded structures for castings provides an economic rather than a technical advantage. Perhaps the most general application of fusion welding in marine engineering construction is in the fabrication of pipes and flange attachments. The combination of screwing and welding for flange attachments is objectionable and choice should be restricted to either an all-weld attachment or a flange screwed on to a pipe having a vanishing thread. Variations in thickness are always a source of danger in a casting whereas in a welded engine structure there are no limitations in possible thickness variations, which comprise an important contributory factor in the saving of weight. Manual welding is usually employed for engine structures, and the major joints, both fillet and butt, are made of multi-pass welding, using a small-gage rod for the initial run, and a larger rod for the super-imposed runs. A stress relief anneal is recommended whenever it is possible to apply it, but in the author's view the treatment is not necessarily for the purpose of relieving residual stress, but certainly for the purpose of improving the quality of the weld metal and the parent plate immediately adjacent to the weld. CEJ (6)

Welding Versus Prejudice. J. F. LINCOLN (Lincoln Elect. Co.) *Welding J., New York*, Vol. 18, Aug. 1939, pp. 475-476. Review. The author states that welding experience has established the following as facts: "(1) Shielded arc deposited metal is definitely stronger than mild steel plate under all conditions; (2) shielded arc weld metal is a good deal more homogeneous than mild steel plate, hence less apt to defect; (3) making of a shielded arc weld requires very little skill, particularly in downhand position. The chance of that weld metal being as good as the parent metal is tremendously better than the chance of the parent metal being as good as the weld." Various inconsistencies of code making bodies are pointed out, *e.g.* in their refusal to sanction the welding of tank cars carrying oil under atmospheric pressure while the oil industry processes the oil in arc welded vessels operating at over 1000° F. and 1,000 lb./in.^{2} pressure. Locomotive boilers may not be welded while locomotive superheaters operating at the same pressure and higher temperature as the boilers are required to be welded. Other inconsistencies are shown. The author considers the rigid inspection of welders and welding production as being carried to excessive limits, thus hampering more rapid development of welding applications and reducing the economy of the process. Data from tests made on student-welded specimens in the welding school of the company show that, "(1) Welds made by novices who had never had any previous experience would have withstood all commercial requirements, (2) a very wide variation (from student to student) occurs in these tests. These are caused largely by the impurities in the plate being carried over into the deposited metal, not by difference in skill, (3) the weld metal is under all conditions better than the parent plate." The opinion is that with the proper electrode, size and type of welding machine it is more difficult to make a weld which is worse than the base metal than it is to make one that is better, therefore inspection of welded joints should be focussed on the base metal rather than the weld metal. See also *Metals and Alloys*, Vol. 9, Aug. 1938, p. MA494 L/8. WB (6)

6a. Ferrous

Coatings and Fluxes in the Welding of Steel. A Review of the Literature to Jan. 1, 1938. W. SPRARAGEN & G. E. CLAUSSEN. *Welding J., N. Y.*, Vol. 18, May 1939, Supplement pp. 153-165. Comprehensive review of one of the most important phases of welding—since the coating and flux are to the weld metal what the refining slag is to steelmaking. The type of inclusions in the deposit, the composition of the deposit and the rate of electrode melting depend on the type of coating. The coating also provides a protective reducing atmosphere, stabilizes the arc and forms a protective slag on the deposited metal. Proper use of certain coatings may also be applied to addition of alloys to the deposited metal through the reduction of alloy metal oxides incorporated in the coating. The coating may also facilitate overhead welding and provide greater penetration of the weld metal into the root. The slag formed from the coating may be similar to the original coating in composition, minus the volatile and combustible constituents and enriched in Fe oxidized from the electrode. The physical behavior of the slag during welding is not fully understood as there seems to be some question as to the form of metal transfer and the possibility of metal protection by a slag coating during transfer across the arc. The slag appears to pile up just behind the arc with covered electrodes. Gas or nonmetallic inclusions in the electrode have been considered by many to cause erratic arc behavior. Splatter loss has been found to be affected by cold working of the electrode metal. The authors say "The problem of evaluating the effect of a single constituent of a coating or flux on all welding factors is baffling and remains to be solved." The fundamental information available from the literature sources is ably presented in the discussion and tabulated data under the headings Electrode Coatings, Composition of Coatings, Manufacture of Coated Electrodes, Metallurgy of Coatings, Slags, Inclusions in Rod (spatter), Inclusions in Base Metal, Arc Stabilizers, Arc Atmosphere, Viscosity, Surface Tension, Miscellaneous Fluxes. 144 references. WB (6a)

Data on the Spot Welding of Low-C Steel. WENDELL F. HESS & ROBERT L. RINGER (Rensselaer Polytech. Inst.) *Welding J., N. Y.*, Vol. 18, Apr. 1939, Supplement pp. 113-115. Original research. The best welds made with just sufficient energy do not have serious indentation even with high pressure. With mild steel the electrode pressures may properly be of the order of 15,000 lbs./in.^{2} as contrasted with 50,000 lbs./in.^{2} for stainless steels. Data are presented for 0.029-in. hot rolled, annealed and pickled steel. The size of the best welds in this thickness of material is the same as the size of the electrode tip. The optimum pressure for welding 0.029-in. hot rolled, annealed and pickled mild steel is 15,000 lbs./in.^{2} The optimum time for the above thickness of material is from 6 to 12 cycles and the currents corresponding with these are 13,500 and 12,000 amperes, respectively. With flat electrodes the indentation produced in welding is a clear indication of the dividing line between proper and excessive values of current, there being a marked increase in the indentation immediately above the optimum value of current. For this thickness of material, the diameter of the optimum weld and those made with excessive currents is the same as the diameter of the flat electrode tip. The shape of the contact resistance curves is an indication of the quality of the weld. For optimum values of current there is always the same general character of curve, while excessive values of current are clearly indicated. The electrode-to-sheet resistances are one and one-half or two times higher than the sheet-to-sheet resistances, in contrast to the case of polished stainless steel where the ratio is approximately doubled and reversed. See also *Metals and Alloys*, Vol. 10, Mar. 1939, p. MA 160 R/1. CEJ (6a)

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Machine Tool Fabrication by Welding, Design and Drawing Office Procedure. A. KERSHAW. *Welding Ind., London,* Vol. 7, May 1939, pp. 140-145. Practical. The welded steel column will give a much smaller deflection than the cast iron, and it is only natural to infer that the excess weight in the cast iron structure has an additional detrimental effect. While it is usual to calculate the value of welds by the throat dimension, this dimension is difficult to obtain in shop practice and it is becoming more common to use the leg or face demension in shop drawings. The drawings as received from the drafting room comprise assembly drawings, each separate part to be cut is numbered or lettered and the numbers indicate the assembly order as far as possible. Detail sheets giving dimensions of every rectangular part are supplied and every shaped part with more than three dimensions is detailed and dimensioned. The sheets also show the quality of steel required. From these sheets the steel is ordered and preparation starts as soon as the material is available.

It is found cheaper to cut plain sections, angles, tees, etc., by horizontal and vertical band saws. Large plates are flame-cut by machine and hand, and a suitable shop layout can provide an orderly flow of materials to the bending machines and welders. The number of passes for a given size of weld is decided by the engineer in charge and present practice allows of the minimum number of passes using the largest electrodes possible for flat welding. A larger number of passes is used for side fillets, vertical and overhead welds. Covered electrodes having a tensile strength of 65,000 lb. as a minimum, 20% elongation in 2 in., and Izod impact not less than 40 ft.-lbs. are used universally. The general welding procedure is to divide up the large jobs into units and to arrange the assembly of such units in such a manner that the minimum of distortion is obtained and that any locked up stresses developed in the units are not cumulative. With good plates and balanced welding it is possible to produce 20-ft. girders with no twist and straight within limits of 1/8 in. in any 100 in. The steady adoption of safe codes and standards for welding will lead to a safe code of shop welding procedure similar to those codes acquired in other industries after years of experience. CEJ (6a).

The Soldering of Alloy Steels (Das Löten legierter Stähle) P. SCHAFMEISTER & H. SCHOTTKY. *Tech. Mitt. Krupp,* Vol. 7, July 1939, pp. 91-96. Practical. The technical variables to be considered in soldering alloy steels are discussed; two factors are important: The effect of the soldering temperature on the properties of alloy steels, and the so-called solder-brittleness. Up to 400° C. the properties are not significantly affected, and soft-soldering can therefore be applied without danger. The most important soft solders are alloys of Sn and Pb, with 25-90% Sn, and sometimes small amounts of Sb; their melting points lie between 180° and 250° C. Solders of higher mechanical strength are available in the Cd-Zn alloys, which melt between 260° and 350° C. Soft-soldering is used principally for sheets. For hard-soldering, the higher temperatures employed may produce considerable change of property of the steel. A recovery of the original properties by heat treatment is usually out of the question as the temperatures of the heat treatment may be about the same as the melting temperature of the hard solder; reheating might also cause solder brittleness. The hard solders most often employed are as follows:

	Cu %	Zn %	Ni%	Ag%	Melting range °C.
Brass solders	42-54	58-46			820- 875
Nickel brass solders	35-65	57-20	8-15		870-1000
Silver solders	30-50	25-46		45-4	720- 855

Best fluxes for soft-soldering are HCl, Zn-ammonium chloride, phosphoric acid, and rosin; for hard-soldering, mainly borax and boric acid. The "creep strength" of hard-soldered parts is twice as great at 300° C. as it is at 350° C. Hard-soldering is employed in the automobile, bicycle and refrigerator industries for soft steel parts. Solder-brittleness of hard-soldered steel is caused by the intercrystalline penetration of the solder into the steel if the steel comes in contact with the molten solder under interior or exterior tensile stress; the condition can occur also in soldered non-ferrous metals, and, sometimes, is even associated with soft-soldering. See also *Metals and Alloys,* Vol. 10, May 1939, p. MA284 R/4. 33 references. Ha (6a)

The Effects of Carbon on the Welding of Plain Carbon Steels —a Review of the Literature to July 1, 1937. W. SPRARAGEN & G. E. CLAUSSEN. *Welding J. N. Y.,* Vol. 18, Aug. 1939, Suppl. pp. 272-288. Extensive review covering the effects on mechanical properties, microstructure, recovery of C from rod or electrode, fusion welding procedure, resistance and forge welding. Increasing the C content of steels is universally found to increase the hardness of the heat-affected zone and to decrease the weldability. However, the data of the review show that practically any C content in plate ¼ to ½ in. thick may be welded under suitable conditions of proper electrode; heavier sections require preheat and post heat treatments. Where the higher C

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steels are arc-welded without preheat, martensite is found present in the heat-affected zone. The tensile strength and notch impact resistance of the heat affected zone are usually higher than the base metal when the multilayer weld is employed. A large, broad bead slowly deposited produces a softer heat-affected zone than do small superposed beads, since the large bead permits lower cooling speed and penetrates previous beads to temper the base metal to a softer structure. Annealing after welding has been found to reduce hardness and increase notch impact value of the heat-affected zone. Detailed discussion is given for fushion welding procedure, resistance welding and forge welding. Bibliography of 106 references and 10 suggested research problems are appended. WB (6a)

Oxygen Cutting of Steel. Part I—Mechanical Properties and Metallurgy. A Review of the Literature to Jan. 1, 1939. W. SPRARAGEN & G. E. CLAUSSEN. *Welding J., New York,* Vol. 18, July 1939, Supplement pp. 217-248. Comprehensive review of a live field in which applications of the new cutting process are increasing rapidly. For mild steels the properties of oxygen cut sections are practically the same as when the sections are machined. The properties obtained by oxygen-cutting the mild steels are higher than when sheared. Oxygen-cutting permits a 180° bend of mild steel specimens. Slightly inferior properties are obtained for the killed and semi-killed steels compared with rimmed steels. The fatigue strength of an oxy-cut surface is 60 to 80% that of a machined or mill-scaled surface but may be improved considerably by grinding off the ridges on the surface. The increase in hardness due to heat treatment of base metal of mild steel up to 2 in. in thickness is an average of 70 and a maximum of 120 Vickers numbers. In general the hardness is increased by thickness of material cut and carbon content. An anneal above 500° C. reduces the hardness to that of the base metal. For the mild steels the hardening effect extends to a depth of less than 0.05 in. and below 0.30% C no difficulty is experienced in machining or carburizing because of the cut edge.

The depth of the heat-affected zone decreases with increasing cutting speed, decrease in acetylene consumption and increase in O_2 purity. The depth of the zone increases with C content of the base metal and with thickness of metal to be cut up to a thickness of 8 in. Beyond 8 in. thickness the increase in depth of the heat affected zone is not so rapid. At the flame-cut surface there is usually a higher C content than in the unaffected base metal but its cause and quantitative estimation have not been established. When the steel contains above 0.30% C preheating to 430° C. or reheating to 630° C. is recommended to reduce the hardening effect on cooling and improve the bend ductility.

The effects of alloying elements on oxygen cutting are summarized as follows: Phosphorus and S in low amounts had no effect. Steels with Al up to 10% or with a relatively thin calorized layer could be cut. The alloys Mo, Si, Mn, Cr, Ni, V, W appear not to prevent oxygen cutting when present in steels in low amounts; in most cases a flame softening operation is required after cutting to prevent cracking. When present in larger amounts some of the alloys prevent the use of the oxygen-cutting process. When a welding process is used that fluxes the scale formed on the oxygen-cut scarves, there is no difficulty in welding the as-cut steel by the oxygen torch, and the physical properties of such welds are high and free of porosity. Illustrations are given, with a bibliography of 153 references and 10 suggested research problems. WB (6a)

Thermit Welding; Process, Procedure and Examples (Thermit-Schweissung; Verfahren, Durchführung und Beispiele) W. AHLERT. *Z. Ver. deut. Ing.,* Vol. 83, May 6, 1939, pp. 515-518. Review. Thermit welding is based on the reaction of a mixture of Al and iron oxide in powder form, $Fe_2O_3 + 2Al = Al_2O_3 + 2\ Fe$; the reaction starts when the ignition temperature of 1100° C. is reached at some point, after which, because it is exothermic, the reaction is "self-sustaining." A temperature of 2400°-3000° C. is attained. The product of the reaction is about 50% Fe and 50% Al_2O_3. This method of welding is very satisfactory for large steel pieces, but for cast iron there is some danger that cracks and fractures may occur along the weld on account of the much greater shrinking of the thermit iron than of the cast iron. This can be avoided by using thermit with higher Si content and without any Mn; it was found practical to thermit-weld cast iron only if the length of the fracture to be welded is less than eight times the thickness of the section. The various mixtures of thermit to be used for different cases are discussed and examples of some interesting welds described. Ha (6a)

6b. Non-Ferrous

Joining Processes for Zinc Alloys (Verbindungsarbeiten an Zinklegierungen) H. SCHNEIDER. *Metallwirtschaft,* Vol. 18, June 23, 1939, pp. 553-554. Practical. Zinc base alloys are quite weldable, the most important process being gas welding; oxyacetylene welding is preferred although oxy-hydrogen is more satisfactory for thin stock. A slight excess of acetylene is used when welding. The parts to be welded are laid on notched carbon blocks so that the edges to be welded lie over the notch. The material must be carefully cleaned before welding. The welding rod is of the same composition as the metal to be welded, and the diameter of the rod should be ⅓ that of the thickness of the material being welded. The weld region should be preheated with a torch. The molten weld metal should be constantly stirred with the welding rod during the welding operation. Good welding technique requires no flux, though pastes of lithium salts can be used. A concentrated solution of ammonium chloride is used to advantage as a flux when welding thin sheet. Good welds average 37,000 lbs./in.^{2} and usually fail, in testing, adjacent to the weld. By cold hammering the weld it is possible to obtain strengths of 55,000 lbs./in.^{2} with a Zn alloy containing 4% Al. Electric arc welding can be used but great care must be used to avoid burning through. The spot welding of zinc alloys, although not widely used, seems promising. Welding is recommended as superior to soldering. The Zn-base alloys containing Al can be soldered with a solder containing 60% Sn, 30% Pb and 10% Zn. GA (6b)

Repair of Light Metal Castings by Soldering, Brazing and Welding (Zur Reparatur von Leichtmetallgussstücken durch Schweissen) EDMUND T. RICHARDS. *Giessereipraxis,* Vol. 60, July 30, 1939, pp. 322-325. Practical. The choice of the method of autogenous repair to be applied exclusively depends on the subsequent application of the casting, with due regard to the mechanical and corrosion properties required. Among the points to be considered in welding are: Use of welding rods of a composition similar to that of the casting, careful and sufficient preheating of parts to be repaired, and intelligent application of fluxes. Fluxes should meet the following requirements: Good solution capacity for Al_2O_3, refining effect on the liquid light metal, melting temperature closely below that of light metal to be welded, easy to remove, and favorable specific weight. The frequently-proposed application of welding rods filled with fluxes is not advised. The much-considered problem of the preparation of the part to be repaired is also touched upon, the author stating that no definite rule can be given, except that cleaning by pickling is rejected. It is pointed out that repair by filling defects with molten metal should be used on a much broader scale. Annealing after welding is not required. Careful cleaning of finished welds by nitric acid pickling and hot water rinsing is stressed. GN (6b)

7 Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

7a. Electrolytic Methods

The Effect of the Basis Material on the Quality of Electrogalvanizing (Ueber den Einfluss des Grundmaterials auf die Qualität der galvanischen Verzinkung) H. DIENBAUER. *Berg- u. Hüttenmänn. Monatshefte* Vol. 87, July 1939, pp. 142-148. Research. Two different types of steel sheet and strip, hot and cold rolled, were studied—of the following compositions:

	C	Mn	Si	P	S	Cu
Open-hearth steel	0.066	0.38	0.00	0.014	0.036	0.24
Electric furnace steel	0.070	0.45	0.02	0.011	0.038	0.11

The Zn deposits were tested for corrosion resistance, porosity, hardness and adhesion. The general conclusions are that differences within a certain group of materials do occur but not always in the same direction. Although differences in porosity are most pronounced, these do not unfavorably affect corrosion resistance. Zinc deposits on sheet are more corrosion resistant, in spite of the poorer surface quality of the sheet than those on strip; deposits on open-hearth steel are better, in general, than on electric furnace steel. This latter result, however, is not conclusive as the electric furnace steel was not made in the regular production process, but by a special procedure. Ha (7a)

7b. Non-Electrolytic Methods

Cleaning Aluminum Alloy Components Prior to Painting and Enamelling. *Light Metals,* Vol. 2, July 1939, pp. 246-248. The type of foreign matter to be removed from Al alloys may be subdivided as follows: (1) Mineral oil blanking compounds, (2) pure oil of a compounded type, as sulphurized cutting lubricants, (3) soap emulsions, (4) heavy soap-base drawing compounds, (5) swarf, and (6) dust and dirt. Hand cleaning is effective for all of the above while solvent vapor can remove 1 and 2, and a combination of solvent liquid and alkali applied in two stages affords an economic solution to many problems. In the case of very large components, hand swabbing with a cloth soaked with solvent is necessary. Special attention must be given joints, rivets, seams, etc. Suitable solvents for hand cleaning are rather few as toxic and other objectionable properties restrict their number. Paraffin oil is satisfactory except for its low volatility, but it is useful for very heavy work. Coal-tar solvent-napthas are satisfactory and they are the least toxic of the solvents. Cellulose thinners are extensively used as they have good cleaning properties and optimum volatility. The author particularly recommends the following practice as being of the widest application for hand cleaning: Treatment with paraffin oil for heavily contaminated work and treatment with 50/50 methyl alcohol and medium coal-tar naptha. Trichlorethylene is probably the best of the vapor degreasers. Vapor degreasing is well suited for handling small work. High losses of the solvent are likely to result when recessed articles are vapor-cleaned, unless they are rotated during cleaning to prevent the entrapment of solvent. Combined liquid-vapor plants in which there are two compartments, one for hot liquid treatment and the other for final cleaning are particularly efficient. This system allows loose dirt to be removed as well as oil. Alkali cleaners can be very efficient, but the author prefers solvent cleaners wherever feasible, particularly where there are recesses in which alkali may be entrapped. Useful tables of properties of solvent and alkali cleaners are included. AUS (7b)

Metal-spray Protection of Refinery Equipment. D. R. JOHNSON & EARL K. DEWEY, JR. (Continental Oil Co.) *Proc. Am. Petroleum Inst.*, Preprint, May 1939. Continental Oil Co. has had good success using the metal-spray process for the protection of refinery vessels against corrosion. It has been found, however, that careful attention to details is the only guaranty of complete success. Reaction chambers metallized with Al have suffered no measurable loss from corrosion in 4½ yrs., compared with a previous average annual loss of 0.036 in. Semi-annual inspection records on 12 Dubbs reaction chambers show an average annual metallizing replacement of 4 to 5% of the total area originally coated. This replacement varies from as little as 1% to as much as 10% for individual chambers. In a refinery where a bubble tower of a cracking unit processing high-sulphur topped crude had lost metal at 0.129 in./yr. by localized corrosion and erosion, 12 coats of 18-8 stainless steel were applied to a thickness of 0.02 in. Two inspections following the installation indicated that successful protection was being secured.

Proper preparation of the surface to be metallized comprises the following essentials: Sand-blast to clean base metal at an angle of approx. 60°, using, preferably No. 4 flint sand (dry-sacked) but not ordinary river sand; use dry air when sand-blasting; under ordinary atmospheric conditions only sand-blast an area that can be metallized during the same 8-hr. shift—in humid weather, area must be sand-blasted within 4 hrs. In the application of the metal spray; absolutely dry air must be used; the coating must be uniform, preferably with a thickness of 0.0015 to 0.0020 in. per coat; highest grade wire must be used; metallization must not be done when the relative humidity exceeds 60%. The following rates of application of coatings in lbs./hr. are suggested as optimum: Al, 1.2-1.8; high-carbon steel, 3-4; low-carbon steel, 3-4; lead, 15-20; Monel metal, 2-2.5; red brass, 3-4; and 18-8 steel, 3-4. The cost will vary from 70 to 75 cents/ft.^{2} for Al, as low as 70 cents/ft.^{2} for Pb and as high as \$2.25/ft.^{2} for 18-8 steel coatings. VVK (7b)

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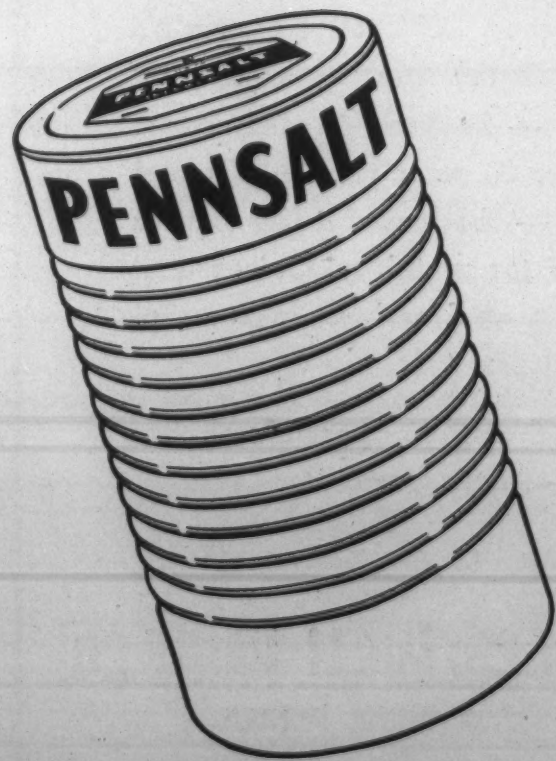

JUST three years ago a new heavy-duty metal cleaner was made available. Almost overnight it became famous. It brought startling new speed to difficult cleaning operations, cut through grease and grime, penetrated the dirt, and left the metal surface characteristically bright and clean. Its economy was equally notable, for a small quantity went a long way, and the saving in time was enormous.

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8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID
AND G. R. HARRISON,
SECTION EDITORS

The Influence of Form and Scale on Strength. RAYMOND J. ROARK, RICHARD S. HARTFIBERG & REX Z. WILLIAMS. *Bull. Univ. Wis. Eng. Expt. Sta.*, Series No. 84. Original research. An investigation of the fracture strength of cast materials is given. The factor of stress concentration at rupture, k_r, was determined for each of a number of cast metals, concrete and plaster, and for each of a number of irregular forms. The determination of N, the ratio of the nominal maximum tensile stress at rupture to the tensile strength of the material as determined by a conventional tensile test, and form factor, F, for each of several structural parts was determined for each of several specimens of cast iron and for plaster of Paris. Theoretical stress concentration factor, k, was determined by photoelastic or mathematical analysis.

A stress raiser causes practically the same reduction in the strength of cast metal, whether it is present in the original casting or is formed by machining. In the case of a machined notch, a very smooth finish results in a value of k_r somewhat less than that produced by a very rough finish. The relative sensitivity of cast metals is different for different stress raisers, and different for different types of loading. In general, k_r varies inversely as ductility, but there are numerous exceptions to this rule, and ductility cannot be regarded as a reliable criterion of insensitivity to stress concentration. For notched specimens, k_r for any given material increases with the sharpness of the notch; this increase, however, is very much less than might be expected from the corresponding increase in theoretical stress concentration factor, k, especially for very sharp notches.

Sensitivity to notch effects is practically the same under impact as under static loading. For the more brittle metals, k_r appears to be slightly less, and for the more ductile metals, slightly greater, for impact than for static loading. For specimens with a sharp V-notch under bending stress, there appears to be no consistent relation between k_r and fatigue strength factor, k_f. The value of k_r for several similar stress raisers placed close together is much less than for an isolated stress raiser of the same kind. For geometrically similar specimens of metal, k_r increases with size. The results of a few tests on Bakelite suggest that in the case of an amorphous material this size effect is absent. In the case of flexural members, for a given form of stress raiser and condition of loading, the effect of changes in proportions (e.g., depth or sharpness of notch) on k_r is similar to the effect on k. Qualitatively, therefore, the effect of such variations on k_r is indicated by the results of photoelastic or mathematical analysis. But quantitatively the results so secured are likely to be misleading when used as a basis for estimating static strength. In the case of members subject to tension or torsion there appears to be no consistent relation of any kind between k and k_r.

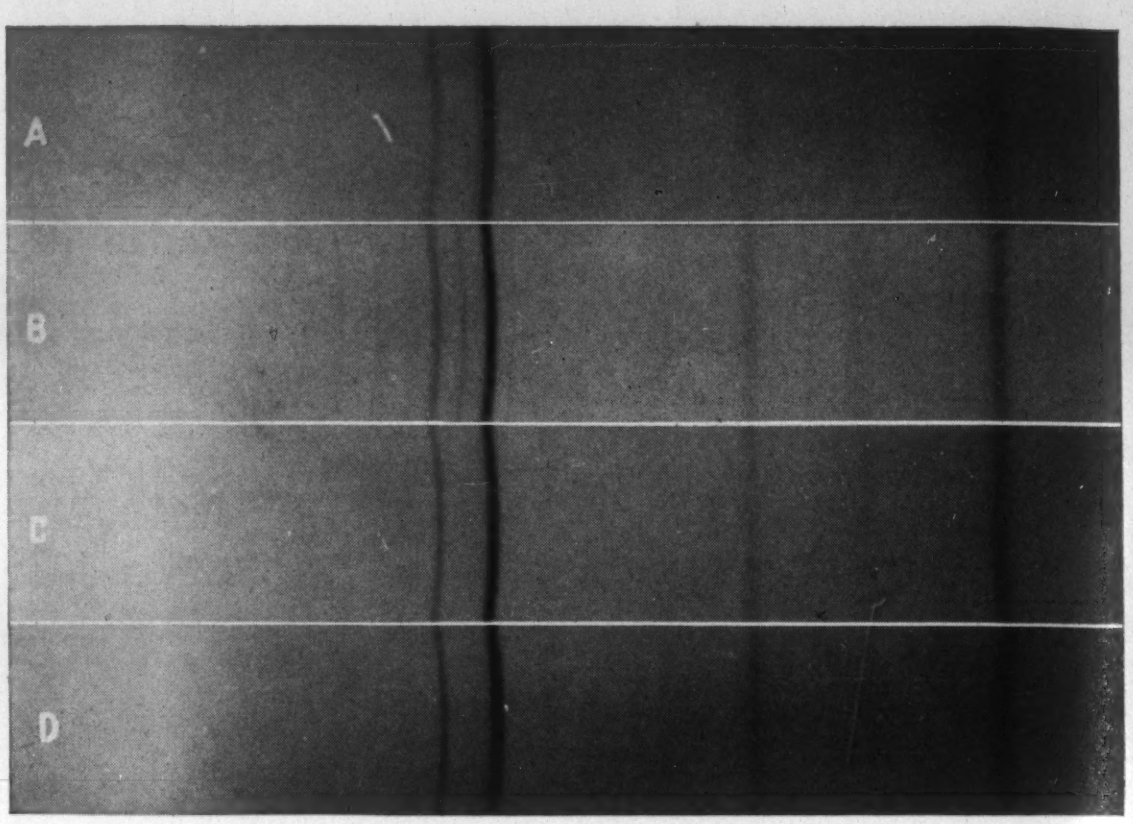
For practically all forms of stress raisers and conditions of loading investigated, plaster gave higher values for k_r than did any of the other materials tested. It is probably safe to assume that the sensitivity of any structural metal is less than that of plaster, and that therefore the effect of stress raisers on the strength of castings can be conservatively predicted from tests of plaster models. In general, both N and F for an element of given form are more nearly equal to 1 when the material is very brittle than when it is relatively ductile. Exceptions to this rule may occur when the compressive strength of a ductile metal is little or no greater than its tensile strength. For a given material, N increases with the degree to which the high stresses are localized, and has its largest values for conditions characteristic of stress concentration. For elements having somewhat similar stress distribution (*e.g.*, straight and curved beams of rectangular section, flat plates) the ratio between the values of N (or F) for two different materials is approximately constant. For an element of any form, N for plaster is smaller than for cast iron; therefore the strength of an iron casting can be conservatively predicted from tests of plaster models. It seems probable that the strength of *any* casting can thus be conservatively predicted, since plaster, being more sensitive to stress concentration of any intensity, probably has, for an element of any form, a lower N than any cast metal. HFM (T-8)

Analyzing Stresses Photoelastically. The applications of photoelastic analysis in determining the stress distribution that occurs in, or will be developed in a structure of a given contour under various loading conditions are rapidly increasing. Results of such studies may be applied in design, through the information they give as to best contour and loading conditions, and also in inspection, to determine cause of failures. Recent developments are surveyed by H. HAINAULT ("Les Developpements Recents de la Photo-Elasticimétrie," *Tech. Moderne*, Vol. 31, Apr. 15, 1939, pp. 281-287). The fundamental principle underlying photoelasticity is that the distribution, orientation and magnitude of internal elastic stresses are independent of the material, whether it be glass, plastic, metal, etc., within an accuracy of 6-7%. Glass and other homogeneous isotropic materials become anisotropic and display birefringence when the loaded specimen is examined in polarized light. Examples are given of the application of this method to bridge design, airplane propeller design, braking of motor shafts, effect of centrifugal force, action of gears, rivets, heating tubes, crankshafts, etc. Considerable work has been done in Japan and France on dyanamic analysis with exposures of 1/45,000-1/1,000,000 sec. Interpretation of results is very important, as it is easy to make errors.

F. O. ANDEREGG, R. WELLER and B. FRIED ("Photoelastic Analysis of a Prestressed Beam," *Am. Soc. Testing Materials*, Preprint, June 1939, 4 pp.) have employed photoelastic analysis to determine the effect of prestressing on beams. The results show that the total prestress on a beam is equal to the total loading stress when the compression in the bottom fiber is just neutralized. For reinforced ceramic beams, more economical use of the steel can be made by applying a prestress of 2/3 the steel's yield point. The design loading may then be taken very safely as 1/3 the load required to neutralize the stresses. The same authors ("Tension Specimen Shape and Apparent Strength," *Am. Soc. Testing Materials*, Preprint, June 1939, 6 pp.) used photoelastic analysis to determine the best shape of tensile test specimens for brittle materials. M. HETENYI ("Application of Hardening Resins in Three-dimensional Photoelastic Studies," *J. Applied Phys.*, Vol. 10, May 1939, pp. 295-300) has developed a new photoelastic method for 3-dimensional stress analysis. The method is based on the property of certain heat hardening resins to retain upon slow cooling an elastic stress state imposed upon the material at a higher temperature. Sectioning into slices, which are studied like ordinary loaded photoelastic specimens, in no way impairs the stress pattern. X (T-8)

Magnetic Analysis Applied to the Inspection of Bar Stock and Pipe. THEODOR ZUSCHLAG (Magnetic Analysis Corp.). *Bull. Am. Soc. Testing Materials*, Aug. 1939, pp. 35-40. Descriptive review. Equipment is described that permits a continuous inspection of bar stock and pipe from ¼ in. to 3.5 in. in outside diam. for freedom of flaws and uniformity of analysis, structure, heat treatment, cold working, hardness, and dimension. Magnetic inspection is suitable for the detection of surface flaws but not for locating internal defects such as pipes. The types of steel particularly suited for magnetic inspection are machine-straightened, hot-rolled and cold-drawn bar stock and sever types of pipe and tubing, including butt welded-cold drawn, electric welded and seamles. Bar stock (all shapes) is inspected for variations in C, Mn, S, and alloys; mechanical defects, such as cracks, seams and deep slivers; structure, such as segregations where these are characteristic of the blow or ingot from which the bars were rolled; and uniformity of heat treatment. Pipe and tubing, depending on the method of fabrication, is inspected for analysis variations, uniformity of heat treatment, weak or open welds, and uniformity of hardness and tensile strength. Practical applications with respect to reliability, selective sensitivity and simplicity are discussed. VVK (R-8)

Lines That Solved A Problem



HERE are the lines—in x-ray diffraction patterns—that led to correction of a faulty manufacturing process, solved a tricky problem.

These four patterns represent four forged bars of a permanent-magnet alloy steel. Coming originally from the same section of the parent ingot, and presumably receiving the same forging and heating treatment, the magnetic properties, nevertheless, were different. Bar A produced a magnet whose high coercivity and remanence were a maximum for the alloy. Bars C and D were of only average quality. In contrast, Bar B was practically worthless as a permanent magnet.

Chemical and spectrographic analysis showed all four to be identical in elementary composition. All four showed identical micro-structures at all magnifications. X-ray diffraction, however, produced three distinctly different patterns, showing definite structural differences.

Pattern A shows the particularly good bar to have the structure of tetragonal martensite, in which all of the alloying constituents are in solid solution. The high residual stresses resulting are indicated by the diffuseness of the diffraction lines. In pattern B are seen several lines in addition to the strong lines in A. Here tetragonal martensite structure is replaced by alpha-iron, the extra lines being from a complex metallic carbide with a cementite structure. This structure indicates that practically all of the alloying constituents have been precipitated, leaving a nearly stress-free alpha-iron bar. The crystallites of the carbide held in the iron matrix are evidently submicroscopic, since they could not be seen under the microscope, and it was for x-ray to reveal the structure indicating magnetic properties in bar B approaching those of soft iron.

Patterns C and D show some lines in addition to those due to alpha-iron or cubic martensite, which were identified as coming from a trace of retained austenite and from a metallic carbide, the latter having a different structure and therefore a composition different from cementite. Thus it is shown that some of the alloying constituents are not in solution in the martensitic lattice and that decomposition of austenite has not been complete. This accounts satisfactorily for the difference in magnetic properties between bars C and D and bar A.

Bars B, C, and D, evidently, had not been heated to a sufficiently high temperature, or had not been held long enough at the proper temperature for complete solution of the carbides to take place before quenching. The difficulty was traced to unequal temperatures in the heat-treating furnace, and was soon eliminated by an adjustment of furnace operating conditions. RESULTS were: an improvement in uniformity of product; decreased losses from rejected material; and elimination of a perennial quarrel between the steel maker and the magnet manufacturer.

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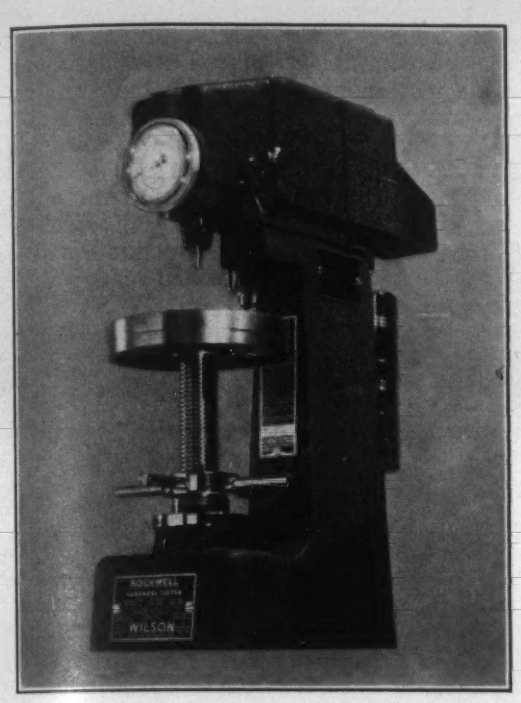
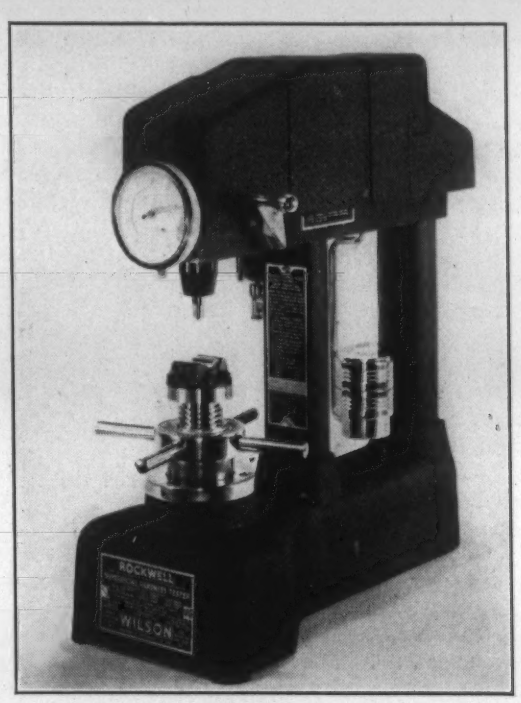
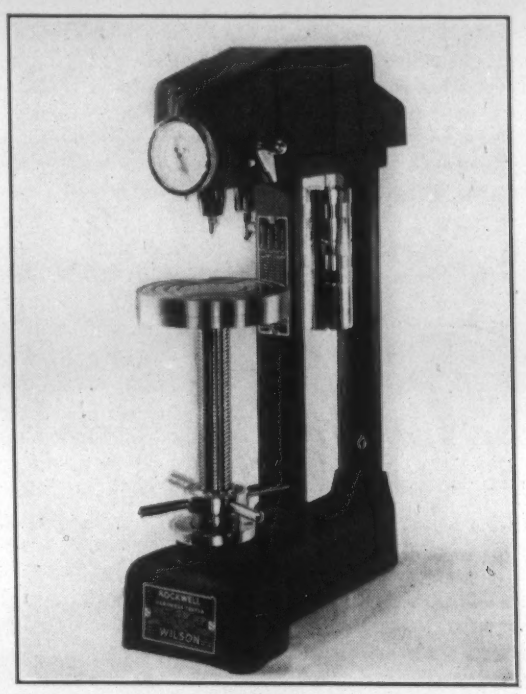


Normal Type Model R. made in two sizes

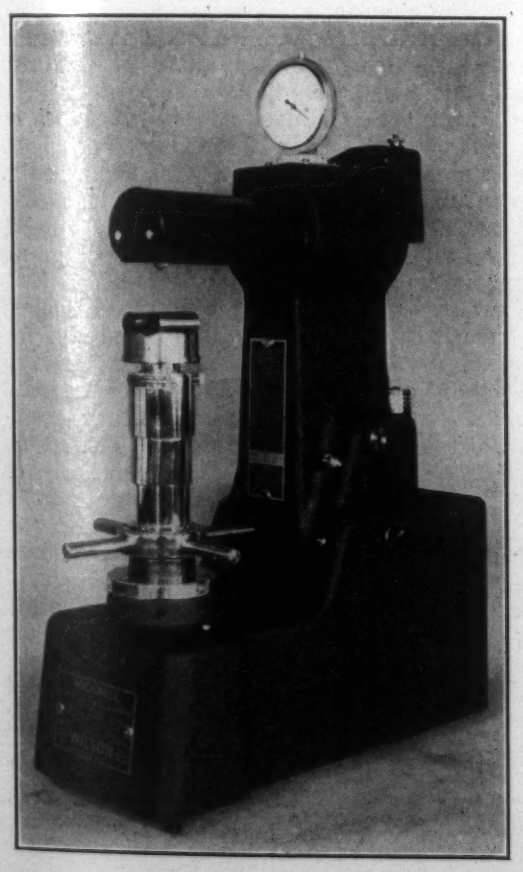


"Superficial" Type Model S made in four sizes



Normal Type Model M made in two tall sizes

The models shown above are used by hundreds of aircraft builders.



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Rockwell Hardness Testing. Two papers before the June meeting of the A. S. T. M. were devoted to some very practical aspects of the ever-useful Rockwell test. In one, correction factors applicable to hardness tests on cylindrical specimens are derived; in the other, correlation is attempted among test readings made under varying conditions and a simple relation is sought between hardness and tensile strength readings. Both papers are contributions of Bell Laboratories men.

W. E. INGERSON ("Rockwell Hardness of Cylindrical Specimens," *Preprint Am. Soc. Testing Materials,* June 1939, 8 pp.) developed a theoretical method for correcting the apparent Rockwell hardness numbers obtained on cylindrical specimens, using the ball penetrator. The deviation of apparent from true hardness is found to vary approximately linearly with the depth of impression for a given specimen diameter, and has been calculated for various specimen diameters from 1/8 in. to 1 in. Experimental results of tests on such sizes of specimens of brass, steel drill rod, aluminum, phosphor bronze and nickel silver, using the Rockwell "B", "F" and "G" scales are presented. The variation in apparent hardness measured on flat and curved surfaces is found to check the theoretical difference, in general, closer than 0.5 of one Rockwell number. Correction curves are presented, by the use of which one can obtain the true Rockwell hardness on the "B", "F" and "G" scales, from measurements made on cylindrical surfaces.

The correlating analysis of the Rockwell test was made by R. L. PEEK, JR. AND W. E. INGERSON ("Analysis of Rockwell Hardness Data," *Preprint, Am. Soc. Testing Materials,* June 1939, 10 pp.) Experiments are reported in which samples of aluminum, mild steel, 6 tempers of grade A brass, 4 tempers of grade B nickel silver, 3 tempers of grade C phosphor bronze and 5 thicknesses of half-hard grade B nickel silver were tested with different loads and ball diameters and the tensile strength subsequently determined. The results indicate the possibility of calibrating the Rockwell tester with a single test block, using various loads and ball diameters and setting up specification limits for hardness measurements corresponding to tensile strength limits. VVK (T-8)

Radiography in Iron and Steel Founding. F. W. ROWE. *Foundry Trade J.,* Vol. 61, 1939, July 13, pp. 27-29; July 20, pp. 43-47. Review. Deals with the examination of internal soundness by both X- and gamma-rays. X-ray can be generated electrically, while gamma-raws emanate from radio-active material. Gamma-ray may eventually be generated electrically, since, present experience indicates that a tube working at a voltage in the neighborhood of 1½ million volts should generate X-rays having a wave length equal to that of gamma-rays. The two principal methods of registering X-ray patterns are fluoroscopy and photography. Roentgen's barium platino-cyanide has the property of fluorescing or converting X-radiations into visible light. Barium platino-cyanide has now been replaced by screens of calcium tungstate and zinc silicate. Screens built up of thin deposits of these salts on glass serve to make visible to the naked eye the radiograph of any object placed between them and the X-ray tube. The image is weak, however, and this fact limits the thickness of metal that may be visually inspected, for while a 200,000-volt tube might yield a good photographic image of 3 in. of steel, the same tube could give a satisfactory image on the fluorescent screen of only ½ in. of steel.

Fluoroscopic inspection is thus only applicable to the detection of large cavities and inclusions in limited thicknesses of metal. The more usual method of X-ray investigation of iron and steel is by photography. In making a radiograph there are 4 main variables, namely the tube current, the tube voltage, the distance between the tube and the film, and the time of exposure. This non-destructive method of testing is often applied as an aid to routine inspection or to the post-mortem investigation of failures. Radiography, however, should not be confined to the field of inspection. Successful attempts have already been made to study the running and risering of a casting on model castings, much smaller than the actual job. The examination of deep cracks and flaws by tomography and planigraphy is now being developed in the research department at Woolwich. AIK (T-8)

A Sensitive Pyramidal-Diamond Tool for Indentation Measurements. FREDERICK KNOOP, CHAUNCEY G. PETERS & WALTER B. EMERSON. *J. Research, Natl. Bur. Standards,* Vol. 23, July 1939, pp. 39-61. Original research and development of instrument for measuring hardness. A sensitive diamond indenting tool was developed which gives indentations of accurately measurable length in the most resistant steels with loads of less than 1 kg. It was found that the use of these light loads permits extension of indentation tests to small specimens and to tests of brittle materials, such as glasses, which shatter under the heavy loads required by present indenters.

The indenter is pyramidal in form, giving a diamond-shaped (rhomb) indentation of which the diagonals have an approximate ratio of 7 to 1 instead of 1 to 1 for the square-based pyramid. Such indenters were duplicated to the required accuracy and showed no discernible wear with use. Elastic recovery of indentations with this indenter takes place in a transverse rather than a longitudinal direction, and consequently, from the measured length of the long diagonal and the constants of the indenter, unrecovered dimensions of an indentation are obtained. Results of tests are expressed as indentation numbers, which relate the applied load in kilograms to the unrecovered projected area in sq. mm. Recovered projected areas also may be determined with an added measurement of the short diagonal. Since knowledge of both recovered and unrecovered dimensions may be obtained, the indenter offers possibilities for study of the fundamentals involved in indentation testing that are not afforded by ball, cone, and square-based pyramidal indenters, which, because of their symmetrical form, yield recovered dimensions only.

The performance of seven indenters of different angular formation was investigated to determine their relative sensitivity and adaptability for use in different materials and to determine also the effect of load and of different dimensional bases of computation on indentation number. Consideration of the results led to the selection of an indenter which gives excellent performance in many materials. Comparison is made of indentation numbers given by this indenter and corresponding Brinell and Vickers numbers for the same specimens. WAT (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Stress Measurements by X-rays Under Fatigue Conditions (Röntgenographische Spannungsmessung am Dauerbruchvorgang) G. KEMNITZ. *Z. tech. Physik,* Vol. 20, May 1939, pp. 129-140. Research. The formulas of Glocker and his associates for the case of a torsional stress condition involving internal stresses, permitting the stresses due to the applied load and the internal stresses to be determined separately at any phase of the load cycle during alternating torsional stressing, are elaborated. The application of the new formulas is illustrated on two types of fatigue test specimens provided (1) with a transverse bore hole, and (2) with a circular fillet. The test bars, of fine-grained C steel with a yield strength of about 40,000 lbs./in.^{2} and an endurance limit in torsion of 20,000 lbs./in.^{2}, were carefully turned, ground to exact size on an emery disk, freed of all traces of grease and annealed in an evacuated and sealed glass tube at about 500° C. Subsequent very slow cooling prevented the origin of cooling stresses and obviated the necessity of etching the surface of the bars. They were stressed in a Schenck static-dynamic reversed bend and torsion machine based on the principle of constant deformation. The motion of the test bar and the X-ray equipment was synchronized to insure sharp X-ray spectra. The results show that the stress peaks in the proximity of the bore hole, or fillet, are sustained by the material in a purely elastic manner until the incipient crack appears, when they suddenly decrease, thereby delaying the ultimate failure of the test specimen. The behavior of the internal stresses during static stressing indicates that the material begins to flow in the direction of tensile stresses before its yield limit is attained. This fact explains the behavior of the stresses due to the applied load during dynamic stressing, and accounts for the prevalence of compressive internal stresses in specimens that have undergone alternating stressing without failure, an observation made by previous investigators. ORS (8a)

A Fatigue Failure with Some Unusual Characteristics. D. D. HOWAT & E. MITCHELL. *Iron & Steel,* Vol. 12, Apr. 1939, pp. 376-380. Investigative. The authors inspected a heavy, mild steel, roll shaft 14 ft. long x 18.5 in. diam., one of several that had failed under short service in a cane crushing mill. Failure occurred in the heaviest section several inches from the shoulder and no tool marks or abrasions could be seen near the fracture. Micrographs are included showing considerable variation in grain size from center to edge of the roll. No evidence could be found of surface decarburization or local over-heating in heat treatment. Physical tests taken on pieces trepanned from center to edge of the shaft showed marked variations and gave certain evidence of a severely worked outer skin, resulting from working the metal after it had cooled too far, which was not repaired by heat treatment. Typically banded structures in both transverse and longitudinal sections also supported this theory. Corrosion and a curious type of pitting on the surface, together with the strains and variations in grain size, were undoubtedly the trouble. HFT (8a)

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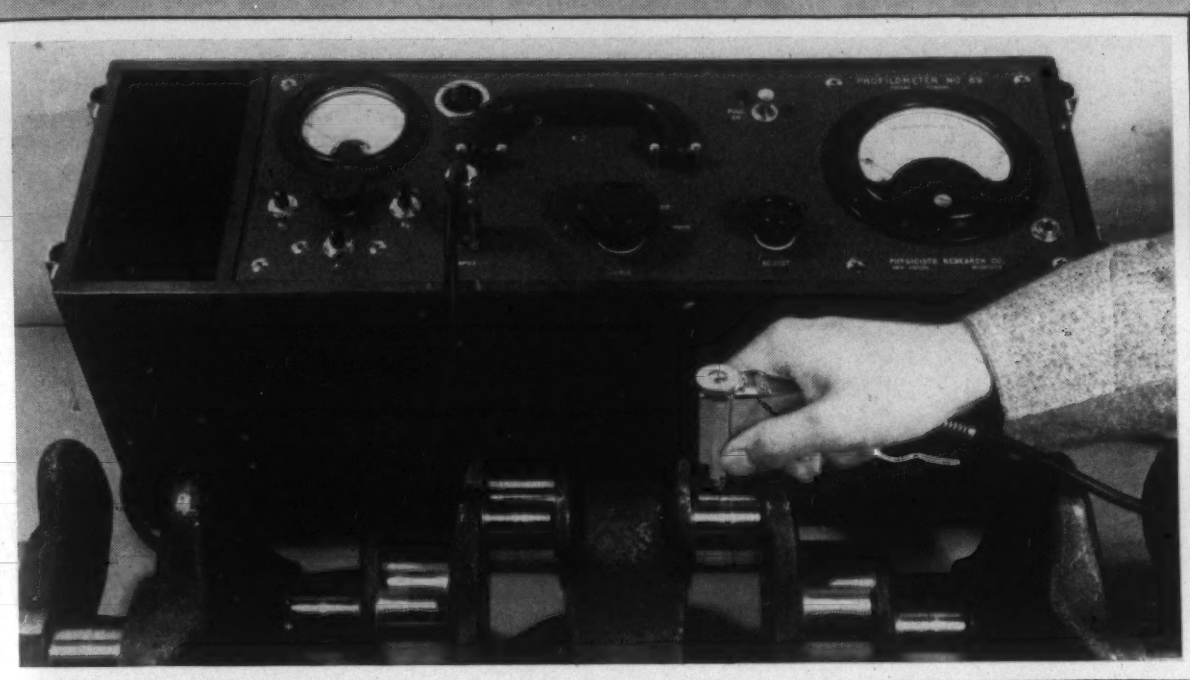

The Profilometer, manufactured by Physicists Research Company, is a portable instrument for measuring surface roughness in the shop. Measures average height of irregularities directly in micro-inches (millionths of an inch).

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9 Metallography

Structure and Constitution. Metallographic Equipment.

J. S. MARSH and C. S. BARRETT, SECTION EDITORS

9a. Ferrous

Brittleness, Plasticity and the Elements of Slip of α-Iron (Ueber Sprödigkeit, Plastizität und die Gleit-elecent des α-Eisens und die Bedingtheit der Gleitflächen) HANS- GEORG SOSSINKA. *Doctor's Thesis, Tech. Hochschule Breslau,* 1939, 30 pp. Original research plus theoretical considerations. In dealing first with brittleness, plasticity and the elements of slip of single crystals of α-Fe at low temperatures, the author describes the results of his experiments on single crystals (15-30 mm. long) of Krupp soft iron (0.03% C, 0.07 Mn, 0.01 P, 0.01 S), which were produced by 72 hr. annealing at 882° C., of 3-4 mm. thick sheets, 3.45% cold-stretched. In tensile tests both cleavage fractures and deformation fractures occurred within a certain temperature range between —98 and —113° C. The temperature range of brittle fracture along the cube face (cleavage fracture) is lower (—185° C. to —98° C.) than that of deformation fracture (—136° C. to —90° C.). Within the temperature range common to both types of fracture the type of fracture could not be related to the orientation. Anomalies of structure, stress distribution or impurities may have as great an effect as the orientation. It was also established that upon tensile loading of α-Fe single crystals at low temperatures, mechanical twinning occurs with (112) as the plane of twinning. The experiments on determining the elements of translation of α-Fe were performed on single crystals of Heraeus electrolytic Fe. Polished single crystals were subjected to small tension or compression loads. At room temperature and with compression loading, (123) was determined to be the plane of translation of α-Fe. The result is of general interest because this face does not represent the closest-packed plane of the lattice, and therefore it is no longer correct to consider closest packing as the characteristic of slip planes. Other experiments showed that the closest packed lattice line is the direction of slip. For the face-centered cubic lattice, the closest-packed plane is one of translation as well as twinning. GN (9a)

9b. Non-Ferrous

Copper-base Alloys. Recent metallographic studies of Cu-base alloys include reports on Be-containing Al-bronzes; Cu-Sb alloys; Cu-Si alloys; and Cu-rich alloys of Al, Mn, P, Sn and Zn. M. BALLAY ("Propriétés de Quelques Bronze d'Aluminium au Glucinium," *Compt. Rend.,* Vol. 208, Apr. 24, 1939, pp. 1309-1311) examined cast alloys containing 9.1-12.0% Al and 0-3% Be. A special compound appears in the 1.5% Be, 10.8% Al alloy and in the 2% Be, 9.1% Al alloy. An Al bronze with 9.5% Al and 0.8% Be gives a homogeneous solid solution after water quenching and a needle-like structure after air-cooling from 850° C. A new Cu-Sb diagram is proposed by T. MURAKAMI and N. SHIBATA ("The Equilibrium Diagram of the Copper-antimony System. 3rd Report: The Transformations in the Solid State," *Sci. Repts. Tohoku Imp. Univ.,* Vol. 27, Apr. 1939, pp. 459-484; in English). The previously-noted θ phase is formed by 2 reactions, the peritectoid reaction $\beta + \gamma \rightarrow \theta$ at 440° C. and the eutectoid reaction $\beta \rightarrow \delta + \theta$ at 436° C. In this paper, a unique application of the electrical resistivity method was made to the determination of the liquidus and solidus. Cu-Si alloys were investigated by C. S. SMITH ("Constitution and Microstructure of Copper-rich Silicon-copper Alloys," *Metals Tech.,* Vol. 6, June 1939, T. P. No. 1073, 17 pp.), who studied reactions involving the new κ-phase adjacent to α in this system. Some most unusual microstructures were observed in the α-κ field, for the 2 phases exist as twin-like plates and do not spheroidize even when grain growth occurs following working and long annealing.

Dendritic structures in a variety of Cu alloys were examined by L. NORTHCOTT and D. E. THOMAS ("Dendritic Structures. Part I—The Influence of Crystal Orientation," *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 832, 12 pp.). Cu-rich alloys of Al, Mn, P, Sn and Zn were cast as 20-lb. ingots in molds consisting of a water-cooled Cu block for base and a cylinder of hot refractory. Orientation of the dendrites was determined by visual examination of etched slices, and these orientations were correlated with orientations of Cu-rich crystals as determined by X-ray analyses. In all cases, the dendrites were perpendicular to [100] planes. A method of determining orientations of crystals from directions of dendrites in α Cu solid solutions is described. X (9b)

Simultaneous Diffusion of Nickel and Silicon in Solid Copper. ROBERT F. MEHL & FREDERICK N. RHINES (Carnegie Inst. Tech) *Metals Tech.,* Vol. 6, Aug. 1939, T. P. No. 1072, 12 pp. Original research. The rates of diffusion of Ni and Si when diffusing simultaneously in solid Cu were determined for the temperatures 850° and 1000° C. and compared with the rates of diffusion of Ni and Si when diffusing separately into Cu. The ternary system involves the pseudo-binary system Cu-Ni_2Si, the solubility of the compound decreasing with decreasing temperature. The precipitate was found by X-ray diffraction to be Ni_2Si. The rate of diffusion of the rapidly-diffusing Si is markedly decreased by the presence of Ni, whereas the rate of diffusion of the slowly diffusing Ni is little affected by the presence of Si. The systems Al-$MgZn_2$ and Al-Mg_2Si exhibit similar behavior. The pronounced interaction of Ni and Si during diffusion is the more marked the higher the concentration. Although the behavior is compatible with the diffusion of molecules, the diffusion of molecules is unlikely. The data can best be explained by the occurrence of momentary strong bonds between Ni and Si atoms when these atoms are on adjacent atom positions, with a retardation in the rate of movement of the more rapidly diffusing solute Si. 15 references. JLG (9b)

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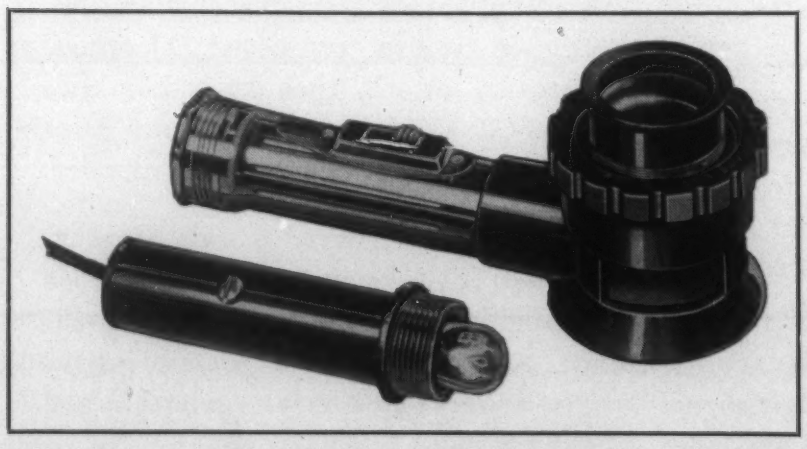

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10 Properties and Applications

Including Relation of Properties to Engineering or Product Design. See also Section 8a and 11.

M. GENSAMER, A. J. PHILLIPS and H. C. CROSS,

SECTION EDITORS

Metals and Alloys in Petroleum Refining. The metallurgical engineer has no more difficult problems to selve than those associated with the applications of metals in oil refining. A broad range of refinery operations, and the suitability of several ferrous and non-ferrous alloys for service therein are covered by several recent articles.

For cracking still tube conditions where the service is too severe for the familiar 4-6% Cr, 0.5% Mo steel, yet not severe enough to warrant the use of stainless steel, a series of steels containing 5-10% Cr, 0.5-1.10% Mo and 0.5-2% Si have been developed. MARTIN FLEISCHMANN ("Five to Ten Per Cent Chromium Content Coming for Cracking Still Tubes", *Natl. Petroleum News,* Vol. 31, Apr. 5, 1939, pp. R-136-138) discusses their applications and some of their useful modifications. Variations in Cr content up to 5% have little effect on either creep or rupture strength. However, load-carrying ability is dependent upon the Cr content because of the greater surface stability of Cr-bearing steels under corrosion and oxidizing conditions. Silicon additions up to 1.5% lower creep strength at 1000° to 1100° F., but their influence is negligible at 1200° and 1300° F. Rupture strength is greatly benefited, mainly because surface and structural stability is affected. Molybdenum improves strength and lessens temper embrittlement, to which straight Cr steels are especially susceptible. Additions up to 1.5% in 5% and 7% Cr steels at 1200° F. are increasingly effective in raising rupture strength but beyond that Mo is not nearly so effective. A 5-2-3 Cr-Si-Mo steel, now under test, surpasses 18-8 in rupture strength at 1500° F. and is its equal in oxidation resistance. Vanadium, in combination with Cr, imparts resistance against hydrogen penetration at high temperature and pressure but adds little or nothing to the rupture strength of two Cr-Si steels tested. Present tendency in steels for hot petroleum products is toward Cr-Mo steel with over 6% Cr. The effectiveness of the Cr in this case is doubled by Si or Si plus Al. In Cr-bearing steels, Si is 7 times and Al 4 times as effective as additional Cr in imparting non-scaling properties in oxidizing atmospheres. A 5% Cr, 0.5% Mo steel with 1.5% Si may be considered as commercially non-scaling at 1500° F. in air. About 10% Cr alone is required at 1300° F. Silicon is also added for the purpose of retention of hot ductility. Regular 5% Cr, 0.5% Mo steel suffers an appreciable loss in ductility after only 1000 hrs. at 1200° F. With an added 0.5-1.0% Si it retains its original ductility.

Much refinery equipment, however, may have to be made of stainless if it is to survive extreme pressure, heat and corrosion conditions economically. K. E. LUGER ("Stainless Steel Applications which Reduce Corrosion," *Natl. Petroleum News,* Vol. 31, May 17, 1939, pp. R-221-224) reviews some recent applications of stainless steels in refineries. For handling refinery products up to 400° F. 18-8 is used because of its better resistance to the reducing acids occasionally present in the products when they are at temperatures below the dew point of water. For handling products from the catalytic polymerization units, 18-8 with 2-4% Mo added is probably the most resistant to wet corrosion when the acids present are reducing in character. Pumps of various kinds are liberally fitted with stainless steel. The pump rods are commonly of the austenitic 18-8 alloy; pump shafts of centrifugal pumps are generally made from the martensitic straight Cr alloys; plungers for hot oil pumps have been successful when made from 4.6% Cr-Mo seamless tubing as well as when made from 18-8 tubing; and valves and valve ports of the plunger type and the piston type of hot oil pumps are frequently made of the stainless alloys. Stainless steels have proved economical for the prevention of corrosion in systems used for the removal of hydrogen sulphide and mercaptans from refinery gases and vapors. Stainless steel bubble caps 0.0625 in. thick have been used in bubble towers handling cracked West Texas crude for over 8 yrs. with no apparent evidence of corrosion. It is estimated that stainless steel liners have been put in over 100 vessels in the field in the past 2 yrs. Generally, 0.08% C, 11-13% Cr steel in strips of from 0.125 in. to 0.070 in. thick by 24 in. wide and 5-6 ft. long are used. For welding rod, the 18-8 steel with 0.5% Ti has been found the most successful.

More detailed information about stainless steel linings is presented by J. T. SHALER ("Field Installation of Chromium Sheet Linings in Pressure Vessels," *Proc. Am. Petroleum Inst.,* Preprint, May 1939, 12 pp.; *Oil & Gas J.,* Vol. 38, May 18, 1939, p. 96). The present practice of his company is to use a 11-13% Cr steel plug-welded through 9/16 in. diameter holes on 4-in. centers, a method that has been successfully used for 10 yrs. Analysis of the lining used is 11-13% Cr, 0.08 max. C, 0.50 max. Ni, 0.30-0.70 max. Mn, 1.00 max. Si, 0.035 max. P, 0.035 max. S. The sheet is hot-rolled and annealed, then white-pickled after annealing and before final inspection. The hardness is Brinell 174 (Rockwell C-7) max., and the material should be free from inclusions, hard spots, seams, laminations or other flaws that would render it unfit for service, and should be capable of being bent flat on itself without cracking on the outside of the bend. The lowest carbon content obtainable should be used as it is believed to be the key to successful installation. The lower the carbon content, the less is the tendency to form chromium carbides during the welding process. The chromium carbides are air-hardening, and result in brittle zones next to the plug and fillet welds. In a typical fractionating-column lining job there may be as many as 15,000 plug welds and as much as 1,500 ft. of seam welding, mostly in the sidehand and some in the overhead position. Hence, the welder must be perfectly trained and all provisions are made for his comfort and protection.

Fifteen-gage sheet is generally used, with 13-gage for lining small nozzles in which it is difficult or impracticable to apply plug welds on adequate center distances, and on installations where the lining is subjected to abuse from mechanical coke cleaners. The button welding of each sheet is completed before making the joint welds. After welding, the sheet is forced against the shell with a pneumatic hammer to eliminate drawing and distortion due to welding. Slag from all button and joint welds is removed by sandblasting. Experience with about 50,000 ft.^{2} of lining over an average period of 6-8 yrs. indicates an annual replacement of 1-2%. One example of service is given by four 8 ft. x 60 ft. 2½-in.-wall combination reaction chambers and fractionating columns lined in 1930 and scheduled for replacement this year, which have thus given 9 yrs. service.

Non-ferrous alloys, too, do special duty in many places in modern refineries. Because of their excellent conductivity and generally good corrosion resistance, copper-base alloys find considerable use in heat exchangers and condensers. E. S. DIXON of the Texas Co. ("Service and Life of Non-ferrous Tubes in Petroleum Refining," *Preprint Am. Soc. Testing Materials,* June, 1939) reviews some of the refiner's problems in finding suitable materials for shell-and-tube type heat exchangers, and particularly those passing water on the inside of the tubes. Such condensers and coolers generally use tubes ¾ in. in diameter, 1/16 in. thick and about 20 ft. in length. In the Port Arthur refinery of the Texas Co. 220,000 tubes are in regular service with an annual replacement of 28%. The ordinary materials to be cooled or condensed are the distillation products of petroleum ranging from naphtha to gas oil and including lubricating distillates. They are corrosive because they are high in temperature and contain corrosive salts such as magnesium chloride, corrosive sulphides and organic and mineral acids. The quality of the cooling water is an important and variable factor. The sodium chloride content varies from 110 to 11,400 p.p.m., depending upon the rainfall in the watershed of the river from which the water is obtained.

Of course, the available alloys vary in their behavior towards these conditions. Red brass fails from water pitting, but not from dezincification to the same extent as does admiralty metal, and its high Cu content makes it readily corroded by sulphides in the distillate. Some improvement with respect to dezincification, has been noted when As has been added to the tube alloy, but a number of such tubes failed due to cracking—a condition, however, which cannot be definitely ascribed to the As. Corrosion is most rapid at those places where oil vapors are condensed to a liquid. Acid corrosion is identifiable by the etched appearance

of the metal. Sulphide corrosion is recognizable through the black scale formed, which upon analysis proves to be copper sulphide. Many tubes are green in color, indicating acid corrosion, and the characteristic deep blue of ammonium copper salts has been found when excess ammonia was applied (as a neutralizer) to the oil stream. Failure of many tubes is caused by erosion and produces an effect similar to cavitation. Steel tube sheets are generally used because of their relatively low cost. Tube holes in brass tube sheets become distorted and therefore useless, after about 2 sets of tubes have been rolled into them. Clad sheets have been used, but the development of this material has not been sufficiently extensive for the price to be favorable for common use, nor has the service been particularly satisfactory. Tube sheets coated by means of a metal spray have been unsatisfactory.

The experience of the Texas Co. for the past 10 yrs. is given. 70-30 brass has made an excellent showing to date. Composite tubes, consisting of copper-lined admiralty metal and copper-lined steel, appear to be satisfactory. Copper-lined Muntz metal has promise; Muntz metal, being higher in Zn than admiralty metal, should resist corrosive oils better, the copper lining resisting the dezincification. Monel tubes are expensive. Stainless steels have been used for exchanger and condenser tubes with poor success. They cracked when subjected to stress, pitted when used with hot brackish waters and were costly. Aside from using better tube material, other methods are being tested. A large capacity cold water deaerator is now under test. Chromates are also used to some extent to inhibit the effect of oxygen in the water, with satisfactory results up to the present. Cathodic protection has been tried with success on one laboratory and on one plant scale installation, and appears to offer wide possibilites. VVK (10)

The Damping of Wires (Die Dämpfung von Drahten) H. BRAUER. *Metallwirtschaft,* Vol. 18, June 16, 1938, pp. 503-505. Report of work conducted at the Wohler-Institut by H. Lüttgerding. The replacement of copper wires by light metal wires in Germany has led to an investigation of the damping capacities of wires. The standard Föppl-Pettz damping capacity machine requires a large specimen and does not give a true indication of the damping capacity of wires, which are usually cold drawn. A brief description is given of a machine for measuring the damping capacities of wires. The machine is an adaption of the Föppl-Pertz machine except that damping in the instrument itself is reduced by substituting an optical system to measure amplitudes of oscillations for the cumbersome pen recorder. The specimen is firmly fastened at both ends in the yoke. The inertia bar is fastened to the center of the specimen, its weight being carried by the specimen. The small axial load has little influence on damping. An example is given of the variation of damping capacity in a given lot of material. The percentage variation is considerable for materials of low damping capacities. The damping capacities of cold drawn and annealed steel are compared, the cold drawn wire having a higher damping capacity at low deformations. Damping curves of aluminum and some of its alloys, copper and steel wires are presented. Pure aluminum has practically the same damping characteristics as electrolytic copper. GA (10)

10a. Ferrous

Cast Iron in Engineering Construction. J. L. FRANCIS. *Iron Steel,* Vol. 12, Aug. 1939, pp. 684-688. Practical review. Cast irons containing 20% Ni, with or without the substitution of part of the Ni by Mn, Cr, or Cu, are austenitic at normal atmospheric temperatures. Such irons possess superior heat resistance, marked corrosion resistance, no ferromagnetism, high electrical resistance and low temperature coefficient of resistance, and high coefficient of thermal expansion. No special problems are presented in founding, but due to increased shrinkage, larger heads must be provided. Chromium additions lower the ratio of Ni necessary and impart added heat resistance, also reduce graphitization and refine the crystal structure. The amount of Cr advised is 1.8%, as more than this decreases machinability. A typical analysis capable of running 1/8 in. sections without mottle is T.C. 1.8%; Si 6.0%; Ni 18%; Cr 2.0%; Mn up to 1.0%. Physical and other properties are listed; compositions are possible that are hardenable by heat treatment to 450 Brinell. For extreme conditions of corrosion Ni may be as high as 40% and Cr 15%. 20% solutions of HCl and H_2SO_4 as well as many organic acids, do not seriously attack Ni-Resist (T. C. 2.8% Si 1.5%; Ni 14.0%; Cr 2.0% and Cu 6.0%) but HNO_3 does. It is also excellent for service in sea-water and as containers for caustic soda. It is tougher than ordinary gray iron and is very machinable.

High-Si irons, with up to 15% Si are discussed. Brittleness and extreme hardness are their chief disadvantages. Compositions are prescribed which give the Si content imparting maximum resistance to attack of acids of varying strengths, and physical properties are listed. The material is not satisfactory for use under conditions of fluctuating temperatures of more than 40° C. variation and is not recommended for vessels operating under more than 50 lbs./in.^{2} internal pressure.

In heat treating cast iron for removal of casting stresses, 450° C. is recommended. Rapid dead annealing of gray cast iron entails heating to 750° C., soaking to assure uniform heating, then cooling slowly. Mottled or chilled irons require 900-950° C. If 5% Ni is added to cast iron the hardness increases to 400 Brinell in the as-cast condition and the iron is not machinable, the limit of machinability in plain cast iron being about 220. The use of 2-3% Ni gives a machinable cast iron of 300 Brinell in the as-cast condition that can be subsequently hardened by a quench and temper to 400 Brinell without danger of fracture or distortion. 2% Si is the limit in cast iron to be hardened by heat treatment since hardness is a function of C content. See also *Metals and Alloys,* Vol. 10, July 1939, p. MA 404 R/2. HFT (10a)

The Effects of Molybdenum in Carbon Steel Compared with Other Carbide-forming Elements (Die Wirkung von Molybdän im Kohlenstoffstahl im Vergleich zu anderen karbidbildenden Elementen) E. HOUDREMONT & H. SCHRADER. *Tech. Mitt. Krupp,* Vol. 2, Mar. 1939, pp. 23-46. Research. Steels with 0.15, 0.45 and 0.90% C, and Mo contents up to 16% were investigated to determine the character and effect of the Mo carbide as compared with V, Ta, Ti, Cb and Zr carbides. The addition of Mo increases the depth of hardening but delays the transformation; these effects are more pronounced the higher the C content. The increase of depth-hardening is much greater than the similar action of Cr in eutectoid tool steels. This indicates a formation of mixed and easily soluble carbides. The delay in the transformation explains the frequent occurrence of needle-like structures in Mo steels, similar to the Widmanstantten structure and, like the latter, depending for its formation on annealing temperature and cooling conditions. Diffusion phenomena in Mo steels are quite different from those in other steels. A stronger surface decarburization seems to point to increased permeability for oxidizing gases, while C diffusion is not materially changed, as shown by approximately the same width of the hypoeutectoid zone. Mo steels show a tendency to irregularities in annealing, with fine-grain areas found, as well as carbide agglomerations. Mo must be considered as a special carbide-forming element, which accounts for the greater heat resistance and creep strength of Mo steels. Oil-hardening gives a slightly lower cutting capacity than does water-hardening of tool steel, probably because of the higher residual austenite content after the former type of hardening. Addition of V and Cr to 3% Mo steel produces a high-speed steel that is equivalent to steel with 4% Cr, 14% W and 2.5% V. The effect of Mo on the properties of steel is somewhat similar to that of Cr. 36 references. Ha (10a)

The Thermal Conductivity of High-duty and Alloy Cast Irons. J. W. DONALDSON. *Foundry Trade J.* Vol. 60, June 15, 1939, pp. 513-516. Research. The thermal conductivity values found for the high duty Ni-Tensyl, Mn-Ni, and Ni-Cr irons indicate the influence that the special element additions, in combination with Si, have on the heat-conducting property of these materials. The Ni-Tensyl and the Mn-Ni cast irons have Si contents similar to that of the plain iron examined. The thermal conductivity values of the 3 irons at 100° C. are 0.101, 0.106 and 0.110. The lower conductivity of the Ni-Tensyl iron is caused by the presence of 1.71% Ni, and that of the Mn-Ni iron by 1.0% Ni. The thermal conductivity of gray cast iron is lowered by Cu in a manner similar to that in which it is lowered by Si and Ni. The influence of Cu, however, is approximately 1/2 that of Si. Molybdenum tends to raise the thermal conductivity of gray cast iron, and in this respect acts in a similar manner to Cr and W, although its influence is not so pronounced. Where Ni and Cr or Ni and Mn are alloyed together in cast iron, the influence of Ni in lowering the thermal conductivity is counteracted to a slight degree by Cr and Mn. A large proportion of Ni has a pronounced influence in lowering the thermal conductivity of cast iron, but where part of the Ni is replaced by Cu, the influence is not so marked. Aluminum, even in the presence of Cr, has a very pronounced influence in lowering the thermal conductivity of gray cast iron. AIK (10a)

10b. Non-Ferrous

Some New Aluminum and Magnesium Alloys. There certainly is no lack of interest overseas in Al- and Mg-base alloys, if the steady stream of new alloy announcements is any criterion. E. HERMANN ("Neues aus dem Patentschrifttum," *Aluminium,* Vol. 21, June 1939, pp. 447-456) surveys recent patents issued in various countries on Al alloys, among them a new heat treatable alloy for liquid-fuel motors containing 6-8.3% Ni, 1.2-2.8% Cu (or Cu + Ag), 0.8-1.5% Mg, 0.1-0.5% Fe, 0.4-1.0% Si, 0.02-0.6% Bi, Ti, Be or Ce (alone, or in combination). Another Al alloy, with 1.8-3% Cu, 1.0-2.2% Mg, less than 1.2% Si, 1.2% Mn and 0.5% Fe + Ti, after annealing and quenching, ages very slowly at room temperatures, so that it can readily be worked as long after quenching as 4 hrs.; the alloy hardens in 1-6 days after quenching. P. S. BANAS ("Aluminum-iron Alloy for Bearings," *Aviapromyshlennost,* No. 3, 1939, pp. 34-39; in

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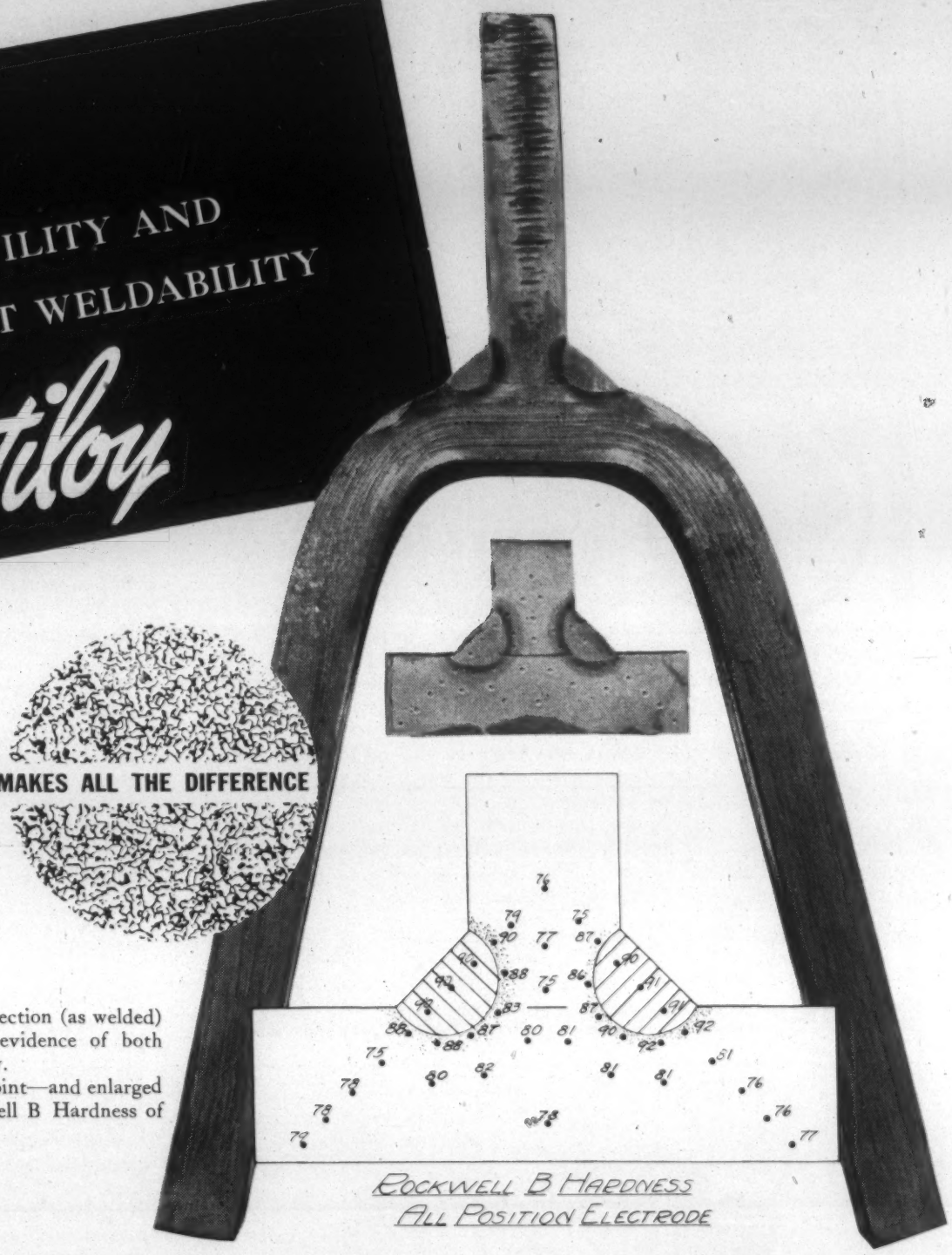

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Russian) finds an Al-Fe alloy containing 6% Fe and 0.5% Mg entirely suitable for bushings in aircraft and diesel engines.

Some new Mg alloys are described by W. F. CHUBB ("Age-hardening Magnesium Alloys," *Light Metals*, Vol. 2, July 1939, pp. 257-262), particularly those containing Cd, Co or Ce. A 10% Cd alloy has nearly 4 times the ductility of the 2% Cd alloy, with about the same tensile strength. Co is used in some complex Mg alloys in conjunction with Ce and Mn; the alloys have good corrosion resistance, and, owing to a high eutectic temperature (635° C.), should find application for use at somewhat elevated temperatures. The addition of Ce to Mg considerably increases the hardness, and the properties of the alloys are retained at elevated temperatures. A number of new Mg alloys containing Al, Cd, Zn, Ag or Mn were prepared and tested by J. L. HAUGHTON and A. E. L. TATE ("Alloys of Magnesium. Part VIII—A Further Study of the Mechanical Properties of Some Wrought Alloys," *J. Inst. Metals*, Vol. 65, 1939, Adv. Copy No. 836, 16 pp.). Several of the Ag-free alloys had properties almost as good as those of the Mg-Al-Ag alloys previously described, and would be, of course, much cheaper. In an investigation of the mechanical and casting properties of alloys of Mg with various concentrations of intermetallic compounds (Sb_2Ni_5, Cu_4Sn, Cu_3Sb or $MgZn_5$), K. V. PEREDEL'SKII ("Alloys of Magnesium with Intermetallic Compounds," *Aviapromyshlennost*, No. 3, 1939, pp. 40-41) finds an alloy containing 5% Sb_2Ni_5 to have a tensile strength of 48,000 lbs./in.^{2} and an elongation of 2-2.5% after hot pressing. X (10b)

The Applicability of Aluminum as Cable Sheathing (Zur Frage der Verwendung des Aluminiums als Kabelmantel-Werkstoff) A. CZEMPIEL & C. HAASE. *AEG-Mitt.*, July 1939, pp. 347-353. Original research. Lead for cable sheathing has been replaced successfully in Germany by organic materials. Aluminum as a substitute is investigated, as it is supposed to allow the use of the complete cable construction without change, by sealing the cable against outside moisture in the same degree as lead. Comparison is made between pure lead and lead containing 1% Sb and aluminum of 99.99% and 99.5% Al-contents. The table below shows the more important physical properties. The close similarity in tensile strength between the higher grade aluminum and lead is stressed. Emphasis is laid on corresponding characteristics in bending tests, the higher stiffness of aluminum is not necessarily a disadvantage, for it can be counteracted by using smaller thicknesses of the aluminum sheet. The higher hardness of aluminum is advantageous, for it promises better protection against external mechanical damage. Vibrational failures of air cables should be less with aluminum because of its higher fatigue strength.

On the other hand, the manufacturing machinery is much more heavily strained by aluminum and cannot be used without considerable change in pressures and temperatures. The higher temperatures necessary in order to use the same equipment endanger the insulation and make high speed necessary. The 99.99% Al is preferable to 99.5% Al because of better corrosion resistance and lower equipment strain. Diagrams show recrystallization curves, creep curves, and press loads for both metals. Some pertinent properties are as follows:

	Pb	Pb + Sb	Al, 99.99%	Al, 99.5%
Young's modulus, lbs./in.^{2}	2,100,000 -2,850,000	2,100,000 -2,850,000	10,000,000	10,000,000
Tensile strength, lbs./in.^{2}	2,300	3,550	5,100	13,000
Yield strength,	....	...	2,300 -6,850	4,300
Elongation, %	55	36	40-50	30
Brinell hardness	3.5	6.5	14	20
Bending value (radius-3.3 dia.)	27	20-25	21	..
Fatigue bending strength, lbs./in.^{2}	625	1,250	3,400	..
Creep strength, lbs./in.^{2} (0.1%/yr.)	100-140	140-280	1,140	..

[It is possible that the pressing need in Germany to substitute their domestic materials for imported ones influenced the interpretation of the results to some degree.—J.M.N.] JMN (10b)

Investigation of Leaded Bronze Castings in the DVL-Bearing Testing Machine (Untersuchung von Bleibronze-Ausgüssen in der DVL-Lagerprüfmaschine) G. FISCHER. *Luftfahrtforschung*, Vol. 16, July 20, 1939, pp. 370-383. Original research. The bearing qualities of 12 Pb-containing bearing alloys supplied by 5 German producers were investigated in the bearing testing machine developed by the German Aeronautical Research Institute (DVL). The analyses of the bearing alloys, which contained 17-42% Pb are given. Plain and hardened shafts were employed. The bearings were tested for maximum bearing capacity under static and pulsating loads, in long-time tests and under discontinuous lubrication.

The majority of the alloys did not pass the tests for highly

stressed bearings. The bearing capacity was found to be reduced by (a) Pb inclusions and pores at the bearing surface, (b) insufficient Pb-content at the bearing surface, (c) contaminating alloy constituents, particularly Fe. The failure in long-time tests caused by cracking and roughening of the bearing surface is associated with (d) coarse dendritic structure, (e) lack of plasticity, (f) stresses due to shrinkage and rapid solidification. The difficulties in producing Pb-bronze bearings are attributed to two opposing requirements: On one hand, high casting temperature and slow solidification are needed to obtain intimate bond between bearing and shell, while on the other, low casting temperature and rapid cooling are essential to obtain the most advantageous distribution of lead. The best results were obtained by a long contact between backing and liquid bearing alloy followed by sudden solidification by quenching. It is denied that a better lead distribution has been obtained by alloy additions to Cu-Pb mixtures. The use of high frequency induction furnaces offers advantages for production of Pb-bronze bearing. The deleterious effect of residual stresses has not been fully recognized. EF (10b)

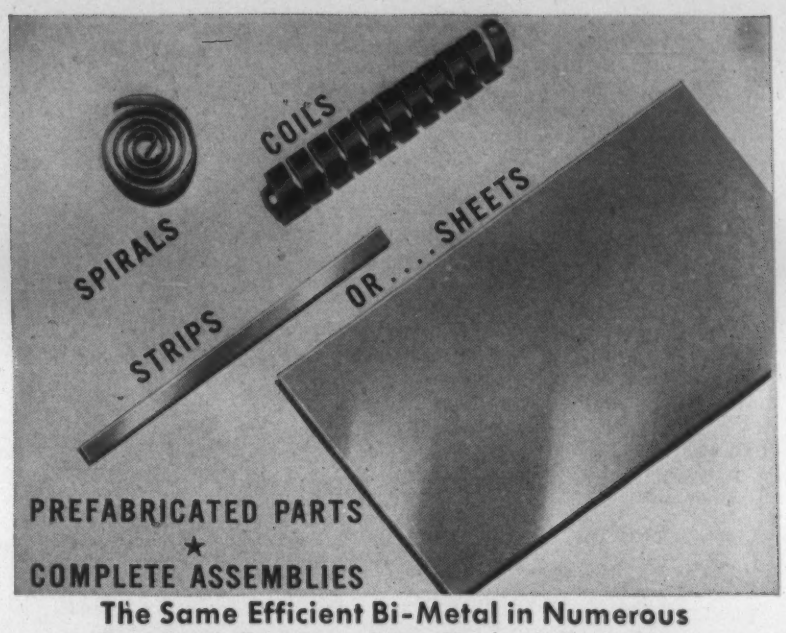
10c. Effect of Temperature

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Sub-Size Charpy Relationships at Sub-Zero Temperatures. H. Habart & W. J. Herge (National Tube Co.) *Am. Soc. Testing Materials,* Preprint, June 1939, 10 pp. Charpy impact tests were made on 8 steels at 70° F. and sub-zero temperatures down to —150° F. The steels tested were (A) SAE 1020 with 5 to 8 McQuaid-Ehn grain size; (B) SAE 1020 with 1 to 3 grain size; (C) SAE 1025 with 5 to 8 grain size; (D) SAE 1035 with 5 to 8 grain size; (E) SAE 2315 with 6 to 8 grain size; (F) 2% Cr, 0.5% Mo with 5 to 7 grain size; (G) 5% Cr, 0.5% Mo with 5 to 7 grain size; and (H) 18-8 Cr-Ni. Standard and ⅔, ½, ⅓ and ¼ size Charpy impact specimens were used. In general, ferritic steels lost impact resistance, as measured on standard and ⅔ size specimens, when the testing temperature was decreased. Smaller specimens have practically constant impact resistance throughout the temperature range used. Steel A, a fine-grain type showed exceptionally good sub-zero impact resistance on all sizes of specimens. Steel B is a coarse-grain type which, while it showed practically no impact resistance for large size specimens at the lower temperatures showed good impact resistance for the small size specimens. Increasing the carbon content seems to produce a decrease in impact resistance. Nickel tends to act as a stabilizer of sub-zero impact resistance, as the impact resistance of steel E was exceptionally good, and the most uniformity between all specimen sizes at all temperatures was obtained with this steel. VVK (10c)

The Resistance to Relaxation of Materials at High Temperatures. E. L. Robinson (Gen. Elec. Co.) *Trans. Am. Soc. Mech. Engrs.,* Vol. 61, Aug. 1939, pp. 543-554. Research. Relaxation tests were made at high temperature to determine the creep behavior of metals. It was established that such tests are particularly useful as they give direct information on permanent tightness of bolted joints and shrinkage assemblies, and are also direct measurements of the effectiveness of strain-relief anneals. Indirectly the tests give, in relatively short time, reliable information on long-time constant-stress behavior, although direct computation of either type of performance from the other is uncertain. The method for performing relaxation tests is described in detail, and a comparatively simple formula is derived that relates elapsed time with residual stress or elastic extension. A number of tests made on steels and structures are described in full with curves. Although under certain conditions relaxation tests of 2,000-3,000 hr. lengths may be extrapolated to give residual stress at 10,000 hrs., no short-time creep test should be considered as trustworthy for long-time predictions. Ha (10c)

Some Things We Don't Know about the Creep of Metals. H. W. Gillett (Battelle Mem. Inst.) *Metals Tech.,* Vol. 6, Aug. 1939, T.P. No. 1087, 44 pp. Up-to-date review. This is the 16th annual Howe Memorial Lecture. The creep of metals is critically and comprehensively reviewed. Deformation beyond the initial elastic extension is considered to occur in 3 stages: (1) The stress-distribution stage, (2) the strain-hardening stage, and (3) the necking stage. The only method satisfactory for predicting creep of metals and alloys is based on the determination of relatively long-time creep curves at the temperature to which the material is to be subjected. A plea is made for more facts regarding the actual behavior of metals subjected to conditions that cause creep. 94 references. JLG (10c)



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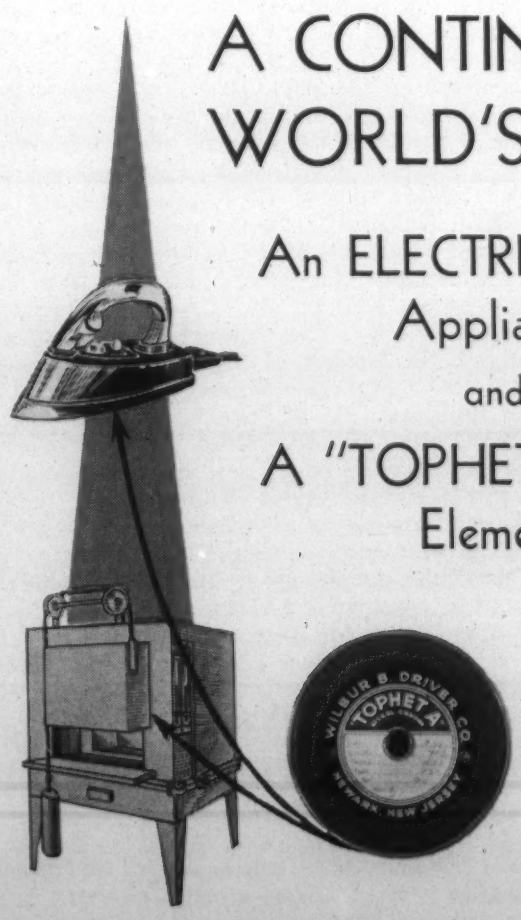

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11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

The Scaling of Steels in Sulphur-free and Sulphur-containing Furnace Atmospheres. Part I.—Scaling at 1000° C. and 1150° C. A. PREECE, G. T. RICHARDSON & J. W. COBB. **Part 2.—Scaling at 650° C.** A. PREECE, E. SIMISTER & J. W. COBB. Second Report of the Alloy Steels Research Committee, *Iron Steel Inst. Special Rept.*, No. 24, 1939, pp 9-63. Original research. The rate and characteristics of scale formation on C and alloy steels in synthetic furnace atmospheres were studied. Particular attention was paid to the composition of the steel, the temperature, and the O and S contents of the atmospheres. Increasing the temperature not only led to a higher rate of scaling, but often completely altered the character of the scale formed and the nature of the attack on the steel immediately below the scale. SO_2 even in small amounts or O, in general, increased the scaling. The intercrystalline penetration of scale into steel that occurred when C and some alloy steels were exposed at 1000° and 1150° C. was absent at 650° C. The high degree of resistance to scaling which characterizes steels containing Cr, Al and Si is due to the initial formation of a protective film on the surface of the metal. When the film became unstable from an increase of temperature or an addition of SO_2 to the furnace atmosphere rapid scaling followed. The presence of as much as 0.2% SO_2 did not increase the amount of scale formed on 18-8 at 1000° C., except when the atmosphere contained CO. JLG (11)

Wear in Lubrication Problems. L. M. TICHVINSKY (Westinghouse Elec. & Mfg. Co.) *Trans. Am. Soc. Mech. Engrs.*, Vol 61, May 1939, pp. 335-342. Survey. Wear testing methods and apparatus are reviewed, the mechanism of boundary and semi-fluid friction taking place in bearings is explained, and a diagram of the important types of wear tests developed. In selecting a type of wear test, the particular conditions of the variables entering in the problem should be considered, *e.g.* the sandblast method and Brinell machine will be correct for wear tests of materials for water turbine blades as they are often subject to wear from sand; but the same methods would be insufficient if used alone, as such blades are also worn by cavitation. How to make the proper choice is discussed at length. 36 references. Ha (11)

Methods of Acquiring Resistance to Corrosion. G. H. CLARKSTON. *Sheet Metal Ind.*, Vol. 13, Apr. 1939, pp. 515-516, 522. Descriptive. Corrosion resistance is important in aircraft materials, because all parts are highly stressed. Stainless steel is best, but is difficult to manipulate, although spot welding is being developed. Stainless steel is now widely used for flying boat hulls. All other steels are Cd-plated before use. Al alloys are protected by cladding with pure Al and subjecting to an anodic treatment. Mg alloys are least resistant and must be protected by chromate treatment plus paint. Monel is sometimes used, but has the disadvantage of high specific gravity. Inspection, fabrication, and cost of these materials are also discussed. Duraluminum and steel are the chief metals to be considered, with elektron metal (Mg alloy) a close second. JZB (11)

Scaling of Cast Iron—Plain and Alloyed. It is easy to forget sometimes, with all the merited interest in the high duty cast heat resistant alloys, that there are many moderate-temperature applications for which plain or alloy cast iron may be entirely satisfactory. The dominant factors, of course, are high temperature mechanical properties, "growth" resistance and oxidation resistance. Some light on the last of these is shed by two recent articles—one on the scaling of plain cast iron, and the other on improvement effected by Cr additions.

Discussing plain cast irons and the adhesion of scale layers thereon, E. PIWOWARSKY & W. PATTERSON ("Ueber die Verzunderung von Gusseisen und die Haftbarkeit der gebildeten Zunderschichten," *Giesserei*, Vol. 26, July 28, 1939, pp. 381-385) call attention first to the better adhesion of scale on annealed cast products than on rolled stock. The scale produced in a weakly oxidizing or alternately oxidizing and reducing atmosphere adheres better than that produced in a strongly oxidizing atmosphere. The intentional production of such layers is called "inoxidation," and has been applied for many years to cast iron utensils, cooking pots, etc. Plain cast iron scales slower than plain carbon steel in the range of 650°-900° C.; above 850° C. the scaling velocities approach each other. The adhesion of scale on cast iron is far superior to that on steel, especially when heated to 750°-900° C. Cast iron with 0.4-0.8% P has a still lower scaling velocity, and the greatest adhesion of the scale layer.

Some interesting data on the scaling of Cr-bearing cast irons are offered by C. O. BURGESS ("Influence of Chromium on the Oxidation Resistance of Cast Iron," *Preprint, Am. Soc. Testing Materials*, June 1939, 19 pp.). Chromium additions were made to a base iron containing approximately 3.00% C, 2.25 Si, 0.60 Mn, 0.11 P and 0.03 S. The Cr additions were from 0.01 to 25.18%, with 11 specimens for each testing condition. The period of exposure was up to 360 hrs. and the test temperatures were 700°, 800°, 900° and 1000° C. Curves are given showing the total oxidation loss at the 4 temperature levels. These represent simple oxidation in air, but the authors believe that the information furnished by these curves will be of practical value in any installation where the atmosphere is predominately oxidizing.

The oxidation tests showed that high-Cr cast irons containing approximately 3% C and 2% Si were not subject to greater oxidation loss than low-carbon, lower Si, Cr steels of comparable chromium content. [Note that Piwowarsky and Patterson found the plain irons better than the plain steels.] From determinations of the rate of progressive oxidation at the 800° and 900° C. levels, it was found that after an initial oxidizing period lasting from 72 to 120 hrs., the rate of progressive oxidation is sharply reduced in Cr-bearing irons. At these two temperature levels as little as 0.54% Cr decreases total oxidation, but 1.06% Cr at 800° C. and 1.99% Cr at 900° C. were necessary to materially reduce the rate of progressive oxidation to negligible values after the initial period. The sharpest drop in progressive oxidation at both temperatures occurred with a Cr content of 1.99%. Approximately 8.27% Cr at 800° C. and 17.06% Cr at 900° C. were required to yield a scale that would furnish practically complete oxidation resistance under the test conditions.

Structural alterations were also traced, and micrographs are given. The occurrence of an abnormal constituent in the unalloyed and very low Cr irons was detected, extending inward from the oxide coating. The constituent appeared to result from a fine precipitation of an iron oxide from a saturated ferrite. It has consequently been designated as the metal-oxide constituent. The formation of the metal-oxide constituent and its degree of penetration is believed to contribute to the growth of cast iron, and to shed some light on this little-understood phenomenon. As little as 0.54% Cr materially decreased the penetration of this constituent into a cast iron, and with a 1.99% Cr content it was completely eliminated even on exposure to 1000° C. This observation may explain the fact that Cr inhibits growth in cast iron to a greater degree than would be expected from its carbide-stabilizing power alone. X (11)

The Electro-chemical Behavior of Alba Alloys (Ueber das elektrochemische Verhalten der Alba-Legierungen) G. GRUBE & H. NAUN. *Alba, Beiträge zur Kenntnis der Edelmetalle als Werkstoffe in der Zahnheilkunde*, 1938, pp. 28-35. Original research. The potentials of different Pd-Ag-Cu alloys (analyses not given) were tested in 0.1% lactic acid and aerated saliva. The pH values of the natural saliva were determined at different times of the day, and found to range between 6.73 and 7.35. Owing to decomposition of the saliva, the testing results were less reproducible than those in lactic acid. A standard dental Au alloy, dental steel, and the Ag-base Pd-Au alloys are all equivalent in lactic acid. The potential of the latter alloys in saliva is less noble (by 0.3%). The e.m.f. values of various galvanic cells with stainless steel as one electrode and dental Au or Ag-Pd-Au alloy as the second electrode were determined. Because of polarization, no current is generated in the steel Ag-Pd-Cu couple. From a chemical viewpoint, the new Ag-base alloys are as immune as the previously used Au-base dental alloys. EF (11)

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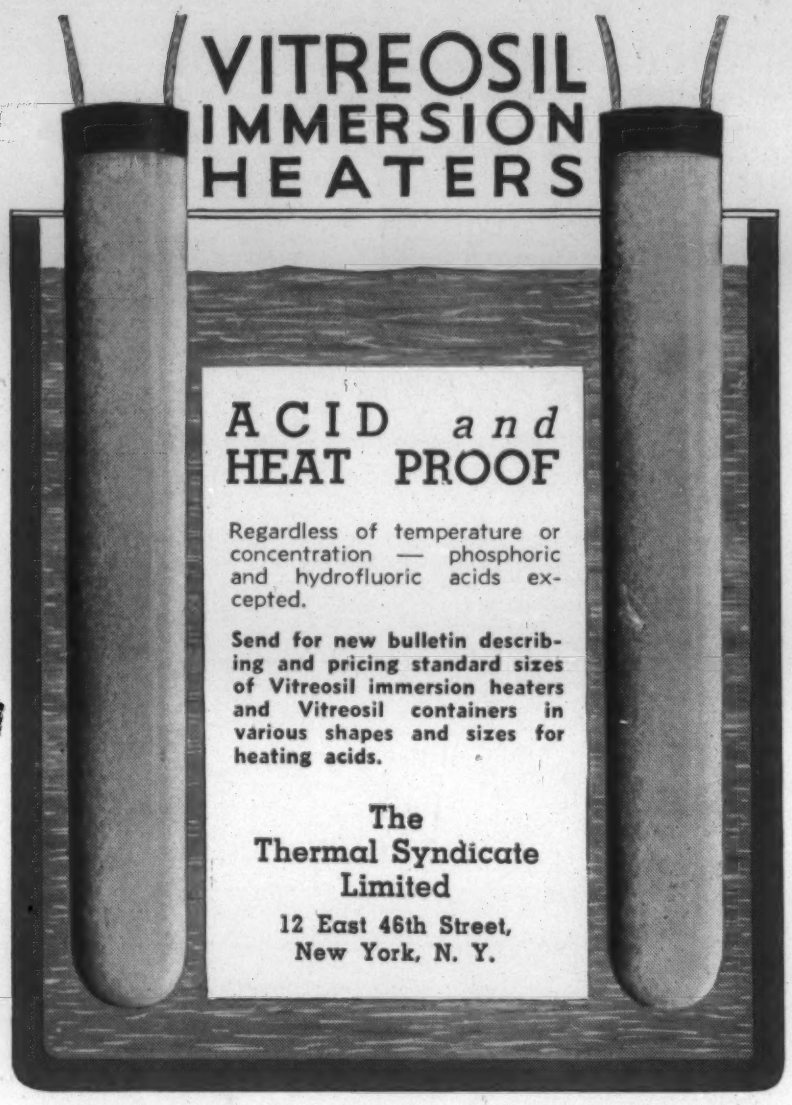


Corrosion and Protection of Magnesium Alloys. *Light Metals,* Vol. 2, July 1939, pp. 229-230; Aug. 1939, pp. 274-276. Review. Possibly the most extensive work on the corrosion of Mg and its alloys is due to Whitby and his collaborators. They were able to show that the amount of corrosion suffered by Mg in NaCl solutions could be measured by the amount of H_2 generated. In the initial stages of corrosion, H_2 is evolved from innumerable points all over the surface, but later on the corrosion seems confined to a few locations whose interstices exhibit a yellowish-brown interference color. Hydrogen is considered by some to be discharged as near as possible to the boundary between cathodic and anodic parts of the surface. In the early stages of attack, the rate of attack is not greatly dependent on the concentration. The later, more rapid attack, is lessened by the formation of a film on the surface of the metal. Oxide and nitride impurities have been thought to have a distinct bearing on the rate of attack of pure Mg, but sufficiently pure Mg to test this theory has not been available. The work of Whitby, however, has indicated that oxide and nitride inclusions do not have any influence upon the rate of dissolution of pure Mg in salt solution at any rate. Whitby has shown that metallic impurities (except Mn) have the effect of accelerating the attack once it has begun. In the case of Mn additions, a progressive deposition of a Mn compound takes place, and this compound behaves cathodically. The difference between the indoor and outdoor corrosion is illustrated by the following analyses of the corrosion products—Indoor: $MgCO_3$ 46.5, $MgSO_4$ 9.8, $Mg(OH)_2$ 15.9, H_2O 27.8; Outdoor: $MgCO_3 . 3H_2O$ 61.5, $MgSO_4 . 7H_2O$ 26.7, $Mg(OH)_2$ 6.4, carbonaceous matter 2.5, silicious matter nil, Fe_2O_3 plus Al_2O_3 2.9.

The metals exhibiting the most corroding action in contact with Mg are the following in descending order of corrosiveness: Pt, Al, Fe, Ni, Cu, Pb, Mn, and Zn; hence none of these metals affords electro-chemical protection to Mg. The effect of Cu in Mg is paradoxical as in binary alloys Cu has a most detrimental effect, but in some ternary alloys it provides certain benefits. Portevin and Pretet have concluded that the rate of attack of binary alloys of Mg is inversely proportional to the hydrogen overpotential of the added metal. On the other hand Evans believes that alloy elements in solid solution retard corrosion in its early stages, but are re-precipitated in metallic form, and then accelerate corrosion by acting as anodes. Manganese does not seem to confer resistance to corrosion by tap or distilled water. Aluminum additions increase resistance of Mg alloys to sea water and also to tap and distilled water. On the other hand, Mn confers corrosion resistance in a wide variety of media. Zinc seems to make little difference; although Cd is useful in binary alloys, it is not helpful in ternary alloys.

While Mn is universally added to Mg alloys for better corrosion resistance, there is an optimum amount in any alloy that must be present for best results. In general, the amount of Mn added is between 0.3% and 0.4%. The Mn should be evenly distributed in the alloy structure for good results, otherwise local attack is likely to occur. Hence cored structures or similar heterogeneity must be removed. Mn in Mg forms a hydrated oxide in the atmosphere, which is dark in color, but acts as a corrosion-preventing film. Before painting Mg for protection, the metal is cleaned in an organic solvent, acid, or alkali cleaner. After the cleaning, a "chrome pickle" or some equivalent process is used to prepare the metal for taking the paint. The "chrome pickle" or "bichromate dip" is probably the most common procedure, and yields a surface that is excellent for painting, and which is more corrosion resistant than merely cleaned Mg. An oil paint is superior to the cellulose ester or gum type, which are less elastic. This is important because of the high coefficient of expansion of Mg alloys. A zinc chromate primer is often used owing to its excellent adhesion and corrosion-retarding properties. For exterior work, oil base, synthetic enamel, or a high grade spar varnish pigmented with Al gives very satisfactory results. Baked enamel finishes are exceptionally durable and are recommended for die castings and small sand castings. The highly corrosion-resistant "Lithcote" process (synthetic resin base finishes), originally designed for finishing the inside of tanks, may also be used for general work.

Although there are numerous solutions which can deposit a thin film on Mg alloys, and which appear to yield protection against corrosion, further examination indicates that these films are not impervious to various corroding media. One of the earliest processes for forming a corrosion resistant film on Mg alloys consisted of heating the Mg alloy in high pressure steam in order to form a hydroxy-compound of Mg to a depth of about 0.01 mm. It was claimed that such a film besides being resistant to sea water and salt solutions, was also a good electrical insulator. However, its insulation was very adversly affected by oxides of the alloying elements. Wolner and Thomas have claimed that Mg oleate and Mg resinate offer adequate protection to Mg and its alloys. The alloys are given a long treatment in an oil-water-soap emulsion, and the coatings obtained are said to be highly chemically resistant and to possess great elasticity, hardness, and resistance to wear, and are capable of taking a high polish. Such coatings are enamel or horn-like according to color and polish, and the treated articles are recommended for various decorative uses. The most useful solution is said to be 2 parts soap, 3 parts linseed oil, and 100 parts water. The layer of oleate formed will vary from 0.001 mm. to 1 mm. thick depending upon the time of immersion. AUS (11)

The Formation of White Rust upon Hot Zinc Dipped Malleable Iron Caps (Beiträge Zur Bildung von Weissem Rost auf feuerverzinkte Tempergusskappen) F. Roll. *Metallwirtschaft,* Vol. 18, June 16, 1939, pp. 497-500. Review plus experiment work. The formation of a white rust after the cementing-in of hot galvanized malleable iron caps of porcelain insulators has been attributed to a poor galvanizing job or to a defective malleable iron (porosity, surface inclusions, etc.). The experiments conducted were concerned with the effect (on corrosion) of the water used for cementing. Zinc-rust formed in water consists approximately of 90% $Zn(OH)_2$, 2% $ZnCO_3$ and 8% H_2O; rust formed in damp air contains about 30 to 55% $Zn(OH)_2$, 40-60% $ZnCO_3$ and 5-10% H_2O. Experiments with water of varying degrees of hardness indicated that in distilled water the attack was greatest, and that in the hard waters it was least. In the case of hard water a zinc carbonate protective layer is formed. Increasing the temperatures increases the reaction velocity. At temperatures from 20° to 60° C. an increase in temperature of 14° C. will double the reaction rate. Increasing the oxygen content of the water will also increase the corrosion rate. Adding cement or CaO to the test water will increase the corrosion rate. NaOH, however, decreases the corrosion rate. The rust formation is independent of the type of zinc or malleable iron. GA (11)

New Viewpoints in Cold- and Hot-water Corrosion (Neue Gesichtspunkte bei der Kalt-und Warmwasserkorrosion) L. W. Haase. *Korrosion u. Metallschutz,* Vol. 15, May 1939, pp. 150-157. Research. Experiments were made to clear up the causes of corrosion phenomena in public and domestic water distribution systems. Complete avoidance of corrosion, especially in hot-water systems, is possible only if all apparatus, pipes and fittings are of the same material, Fe *or* Cu; use of Fe pipes with Cu or brass fittings will always give rise to local currents and consequent corrosion. A slight addition of phosphate to the water forms Fe-Ca-phosphate layers on the inside of pipes, which are very dense and only slightly soluble, and give fairly good corrosion protection. The kind of phosphate must, however, be selected carefully according to the type of water, and added in sufficiently low quantity, as otherwise no protective layer is formed. Filters can also produce local currents and thus contribute to corrosion. The conditions are discussed at length. Ha (11)

Corrosion of Iron and Steel, Report of A. S. T. M. Committee A-5. *Preprint, Am. Soc. Testing Materials,* June 1939, 110 pp. Subcommittee III reporting on Inspection of Annapolis tests presented a table of data on failures of 22 gage sheets. After 22 yrs. 72 out of 79 non-copper (under 0.15% Cu) sheets had failed and 52 out of 141 copper-bearing (0.15% Cu and over) sheets had failed. Subcommittee VIII on Field Test of Metallic Coatings gave a detailed report on original characteristics of wire and wire products including micrographs of base metal and coatings, chemical analyses, physical properties, weight and chemical analyses of coatings. Detailed tables are presented giving the results on the atmospheric corrosion tests on wire and wire products after about 2 yrs. exposure at each of 11 locations. Visual inspection showed the following indications: (1) *Zinc-coated specimens.* Extensive rusting has occurred at Pittsburgh in 2 yrs. and some at Sandy Hook and Bridgeport. The wires rusted at Pittsburgh involve those carrying coatings up to about 0.8 oz./ft.^{2}; at Sandy Hook, 0.45 oz./ft.^{2} (and lighter) coated samples; and at Bridgeport, 0.35 oz. and lighter coated samples. (2) *Copper-covered specimens.* No rusting of these wires has occurred at any location in 2 yrs. (3) *Lead-coated wires.* All of the lead-coated wires at all locations have developed a rusted or rust-like appearance. The discoloring iron corrosion products have been reported in all cases as appearing in patterns of speckles, seemingly at pinhole points in the coatings. Quantitative data will be provided by future tests on the tensile strength of removed specimens. (4) *Uncoated corrosion-resistant steel wires.* No significant corrosion of these wires had developed at any location in 2 yrs.

The tensile test data showed the following indicated trends. Ordinarily zinc-coated wires do not show significant losses of strength until after rusting of the base metal has started. The order of corrosiveness of test locations (most severe to mildest) is: Pittsburgh, Sandy Hook, Bridgeport, State College. All of the other 7 locations seem milder than State College but definite ratings are not yet possible. The Cu-bearing uncoated wires are corroding less rapidly than those of low-Cu content at Pittsburgh. Thus far the differences do not appear significant at the other locations. To date there is no very clear-cut indication that the lighter gage uncoated wires are being penetrated more rapidly than the heavy gage ones, although the data for the Pittsburgh removals might be so interpreted. The annual loss of strength (as well as the calculated diameter decrease) of the wires at Pittsburgh carrying the lightest zinc coatings is about the same as that for the bare wires at Pittsburgh. In drawing this comparison, the date of initial rusting of the coated samples has been estimated and the changes figured as annual effects since this date. Findings from the weight-loss specimens indicate a tendency for the lighter gages of wires to lose coating somewhat faster than the heavier, and there appears to be no significant difference in corrosion rates of wires exposed on the east side of the test racks, as compared to those exposed on the west side. VVK (11)

On **Cast Iron Brake Shoes for Railway Rolling-Stock.** RYOZO NAKAMURA. *Trans. Soc. Mech. Engrs., Japan,* Vol. 5, May, 1939, Abstract Supplement pp. 548-549. In English. Original research. The interrelation between chemical analysis, abrasion and coefficient of friction was studied on 50 pairs of cast Fe brake shoes. The study was made with a testing machine that rotates a passenger-car wheel whose revolving mass is equivalent to an axle load of 12 tons at a specified speed. The composition range covered by the different grades of cast iron was as follows: 2.64-3.53% total-C, 0.69-1.42% combined-C, 1.64-2.61% free-C, 0.96-1.78% Si, 0.43-0.88% P, 0.33-0.85% Mn. Abrasion decreases and braking effect increases with rising P content, the effect of which on abrasion is remarkably great for high-C cast iron. Less total-C results in less abrasion and better braking effect. Less free-C causes less abrasion, but abrasion increases abruptly when the free-C content is over 2.2%; less free-C lessens the braking effect. The best composition of cast iron for brake shoes seems to be: 2.8-3.0% total C, 1.9-2.1% free C, 0.7% or more P, 1.2-1.4% Si, 0.1% or less S. EF (11)

Threshold Treatment of Municipal Water Supplies: Use of Sodium Hexametaphosphate. OWEN RICE & G. B. HATCH (Hall Laboratories, Inc.) *J. Am. Water Works Assoc.,* Vol. 31, July 1939, pp. 1171-1185. General discussion of the use of sodium hexametaphosphate for prevention of calcium salt deposition and corrosion prevention. Two p.p.m. is all that is necessary to prevent or decrease to a minimum deposition of calcium carbonate even from waters containing a large amount of Ca. Already-formed scale is slowly dissolved and no trouble from corrosion has been encountered from bare steel where this treatment is used. It is believed that the precipitation of calcium carbonate is prevented because the sodium hexametaphosphate has the ability to segregate nuclei of calcium carbonate as rapidly as they develop in the water, so that in effect it is possible to stabilize a condition of even extreme supersaturation with respect to this substance. Sodium hexametaphosphate is very strongly adsorbed on the surface of many metals, metal oxides and salts. 10 references. VVK (11)

12 General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

Manufacture of Non-porous Alloys from Powders. W. D. JONES. *Metal Treatment,* Vol. 5, Spring 1939, pp. 13-16. Critical review. Although powder metallurgy permits of the manufacture of either porous or non-porous products, most attention has been given in the past to the porous compacts, because these can be obtained in no other way. However, non-porous alloys produced from powders are becoming increasingly important. One method of producing non-porous sintered compacts from metal powder mixtures by cold-pressing is to follow this operation with heat treatment under such conditions that one constituent melts and forms a liquid bonding phase. The work of PRICE, SMITHELLS and WILLIAMS (see *Metals and Alloys,* Vol. 9, Aug. 1938, p. MA 505 R/8) on "heavy metal" alloy comprising tungsten bonded with 5% Ni and 2% Cu is described. This technique may be applicable not only to powder mixtures in which there is an appreciable difference between the melting points of the constituents, and in which the metal of lower melting point, while readily dissolving the other is itself relatively insoluble, but to any alloy system having a reasonably wide melting range. If heat treatment is carried out at a temperature between solidus and liquidus, shrinkage and consolidation are to be expected, provided that the liquid is formed by interaction between the solid particles and some other phase. Mixtures of Pb and Ag, after sintering, have given densities 95% of the theoretical. Numerous other alloys that would probably respond to such liquid-phase bonding technique are indicated. Cold-pressed compacts may also, in certain instances, be rendered non-porous by heat treatment for long periods, depending on the particle size, in a reducing atmosphere. Many difficulties might be overcome by using a hot pressing technique. Hot pressing is applicable to most alloys, and often results in better mechanical properties. It allows more accurate sizing, since there is no shrinkage, and also can often be done without the use of special atmospheres. It is, furthermore, less time-consuming than the more widely-used cold pressing and sintering practice. JCC (12)

Zink. *Metallwirtschaft,* Vol. 18, June 23, 1939, pp. 513-560. This issue of *Metallwirtschaft* is confined to zinc and its alloys and their processing as practiced in Germany. Sixteen technical papers by various authors are presented. The following subjects are discussed: "Decreasing the Use of Copper by Replacement with Zinc"; "The Important Zinc Alloys"; "Crystallography of Zinc Alloys"; "Hot Pressed Parts"; "The Production of Metal Fixtures from Zinc Forging Alloys"; "Machinability Tests on Zinc Alloys"; "The Machining of Automatic Screw Machine Stock of the Composition Zn-Al-Cu"; "Advances in the Use of Zinc Alloy Sheet as a Substitution Material for Copper and Brass"; "Production of Fixtures from Zinc Alloys"; "Experience with the Use of Zinc Casting Alloys in Sand Castings"; "Coloring Processes for Zinc Alloys"; "Dyeing Processes for Zinc Alloys"; "The Chrome Plating of Zinc and its Alloys"; "The Silver Plating of Zinc Alloys"; "Joining Processes for Zinc Alloys"; and "The Properties of Hot Dipped Zinc Coatings." GA (12)

CURRENT news

Francis C. Frary Awarded Acheson Medal

The 26th meeting of the Electrochemical Society was held in New York, Sept. 10 to 13, and was well attended despite the fact that two other technical organizations in the chemical field were meeting at the same time in different cities. Monday afternoon, Sept. 11, was World's Fair day and at 5 p.m. a lecture in the Little Theatre on the grounds was delivered by Prof. Bradley Stoughton on "Modern Marvels of Electrometallurgy."

Most of the 28 technical papers scheduled dealt with subjects outside of metallurgy. One paper of decided interest was "Anodes for Electromining of Manganese" by Colin G. Fink and Morris Kolodney. It presents what is claimed to be an improved anode of Pb, Sn and Co by which a greater yield of Mn is obtained.

At the reception and dinner on Tuesday evening, Sept. 12, the Edward G. Acheson Medal was awarded to Dr. Francis C. Frary, director of research, Aluminum Research Laboratories. Preliminary to the presentation by Pres. Creighton, speeches were delivered by Dr. J. D. Edwards, assistant to Dr. Frary, on the technical achievements of the medalist, and by Sidney Kirkpatrick, editor of *Chemical and Metallurgical Engineering*, on personal traits. Dr. Frary is the sixth recipient of the medal which is awarded every two years.

Along with the medal goes a prize of $1,000. Dr. Frary announced a gift of this to establish a fund to assist young men in the Aluminum laboratories to broaden their education. S. K. Colby, vice-president of the Aluminum Co. of America, was present and stated that the company has added $2,000 to the fund and named it the Frary Fund.

Motor Oil Filter Research at Mellon Institute

Dr. Edward R. Weidlein, director, Mellon Institute, Pittsburgh, has announced the establishment of an industrial fellowship in that institution by the Fleming Mfg. Co., Providence, R. I. This fellowship will study the design, construction, and operation of oil filters. One aim will be to obtain new knowledge to bring about improvements in the products of the donor.

Dr. Glenn O. Ebrey, who has been appointed to the incumbency of the fellowship, received his professional education at Illinois College (B.S., 1924) and at the University of Pittsburgh (Ph.D., 1931). During 1931-32 he was research chemist with the Sinclair Refining Co., research and development division, East Chicago, Ind. For the past seven years—up to July, 1939—he was chief chemist of the Pennzoil Co., Oil City, Pa.

Symposium on Temperature

This symposium will be held in New York at the Pennsylvania Hotel, Nov. 2 to 4, 1939, by the American Institute of Physics, 175 Fifth Ave., New York, with the cooperation of the National Bureau of Standards, the National Research Council, and officers and committees of many technical societies.

The program is in charge of representative committees of authorities in various fields, who have arranged for a program of 100 or more papers on scientific and technical subjects, which will be presented in concurrent sessions of selected groups. All interested persons active in science or engineering are cordially invited to attend the sessions, and take part in the discussions of papers. A complete program containing full abstracts of the papers to be presented will be mailed in advance on request to the Institute.

There will be a registration fee of $1.00. The chairmen of the committees are Gustav Egloff, A. E. Ewell, C. O. Fairchild, J. D. Hardy, H. F. Mullikin, F. H. Norton, R. B. Sosman, C. B. Veal, H. T. Wensel, and C. B. Wilkes. H. A. Barton, director of the Institute, is chairman of the main committee.

Molds and Dies by Electroforming

A new method of preparing iron molds, steel dies, and other products was demonstrated before a large gathering of editors at a luncheon at the Essex House, New York, Sept. 12, by the United States Rubber Co. The process is known as electroforming or the electrodeposition of metallic iron on a pattern and the exact production of a mold. Started as a process of making tire molds, it has developed into other uses. The deposits can be made up to ½ in. thick and the iron, 99.98%, can be carburized and hardened for dies for stamping and forging, it is claimed. The new method has been named "Ekko."

A more detailed account of it is found in our new equipment section.

Union Carbide Absorbs Bakelite

The board of directors of Union Carbide & Carbon Corp., New York, has approved an agreement for the acquisition by Carbide of all the assets of the Bakelite Corp. Carbide is a producer of chemical raw materials and Bakelite a user of chemicals in its converting activities. The consummation of the agreement will bring valuable supplementary facilities to both organizations, it is believed. The coordination of technical knowledge, research, production methods, and distribution facilities of these two organizations will result in the improvement of existing products, the development of new plastics and other chemical compounds, and the discovery of new uses for such materials.

Bethlehem's Exhibit at World's Fair

An educational display entitled "How Steel is Made" is the central feature in Bethlehem Steel Co.'s exhibit at the New York World's Fair. Entering the Metals Building the visitor finds his attention immediately attracted by a life size, 55-ton, all-welded ladle, suspended from the ceiling, with the reddish glow from its contents of molten steel playing overhead, and a stream of white hot metal, simulated by illuminated lucite, flowing into a full size ingot mold underneath.

Below this impressive display, in a circular arrangement, are 6 animated panels showing the principal operations in steel making, starting with a blast furnace, then an open-hearth furnace, pouring platform, soaking pit, blooming mill, and typical finishing mills. Sound recordings describe each step in natural sequence, while the construction and the operations of furnaces and equipment are vividly and realistically portrayed by colored lights and moving parts. Wherever possible the furnaces are shown in cross section, making the presentation more understandable as well as highly dramatic.

Three additional panels, completing this display, give the quantities of materials required in the production of one ton of coke, one ton of pig iron, and one ton of steel.

Surrounding the central display are a number of supplementary exhibits. General uses of steel are brought out in a 40-ft. mural representing a typical community, with business, manufacturing, and residential sections, and adjacent countryside. One section of the exhibit is devoted to Bethlehem products, ranging from the smallest parts to 36-in. beams. A special ship building exhibit centers around an attractive model of the new liner Panama, which was built at Bethlehem's Fore River yard.

G. E.'s Copper-Coated Building

The New York World's Fair has proved a testing ground for a coating developed by the General Electric Co. which promises to provide a new use for copper as a building material. With Glyptal, an alkyd resin, as the coating, the copper on the exterior of the General Electric building at the Fair has maintained its brilliant lustre and characteristic color, instead of turning green or showing brown spots soon after exposure.

The surfaces of the copper panels are cross-crimped, producing striking effects with the shifting rays of the sun. The same indentations give the walls of the irregularly shaped building a shimmering effect under amber floodlighting at night. Covering the exterior of Steinmetz Hall, the "House of Magic" and the exhibit area of the G-E building are 26,500 sq. ft. of copper panels treated with the Glyptal coating. To provide a contrasting color, setbacks at the top of Steinmetz Hall and the rear wall of part of the building are paneled with copper treated with acid, producing artificially the characteristic color of weathered copper.

The coating had been pre-tested on sample panels, but the G-E building at the Fair provided the first actual use of the material. Glyptal is an alkyd resin and has been used for several years in paints and other coating materials. Among its general uses have been refrigerator enamels, automobile finishes and other exterior finishes requiring the utmost in durability.

Quenching High Carbon Steel in Calcium Chloride

Numerous manufacturers of high carbon steel are quenching the heated metal in a calcium chloride brine solution according to The Dow Chemical Co., Midland, Mich. These manufacturers claim this solution to be superior to quenching in plain water since it removes the scale developed during the heating process and eliminates the possibility of soft spots.

According to Dow, the manufacturers who are purchasing Dowflake Calcium Chloride for this purpose, use an 18-20% solution which is kept at a temperature of 80 deg. F. The hot steel, at a temperature of about 1550 deg. F. is quenched in this solution, then taken by conveyor to a cleaning bath where the calcium chloride solution is washed off in preparation for painting.

The Thurston Centennial

The centennial of the birth of Robert Henry Thurston, the great pioneer in engineering education and first president of the A. S. M. E., will be celebrated on Oct. 25 at Ithaca, N. Y., by Cornell University in cooperation with the A. S. M. E. Delegates from American and Canadian engineering schools, technical and academic societies in this country and abroad of which Dr. Thurston was a member, and other organizations, together with the alumni of Stevens Institute and Cornell University from the classes in Thurston's time will be special guests.

The celebration will be a one-day affair, including an academic procession and convocation in the morning, an exhibit of Thurston's publications and of laboratory apparatus he designed, and other events, details of which will be announced later. The ceremony is designed to recall and emphasize the distinguished contributions of Dr. Thurston to engineering education, where the broad principles he laid down are still the guiding force today. Dr. Thurston was considered an authority on materials of construction, steam engines and boilers, and the history of engineering, as well as on the philosophy of education. His most widely known work, "A History of the Growth of the Steam Engine," published originally in 1878, is scheduled for republication this year as part of the celebration of the Centennial of his birth.

Testing of Rails in Track

In the past 10 yrs., Sperry Rail Service, Hoboken, N. J., has made continuous progress, both as to more extensive use of the service by railroads, and improved performance in fissure detection. In the first 6 months of 1939, more track miles were tested by Sperry detector cars than in any corresponding period of Sperry's history, indicating that Sperry testing is being accepted by the majority of Class 1 railroads as the standard for testing rails in track.

Aluminum Research Laboratories Expand

Greater facilities for research in aluminum will be available upon completion of the additions at present being made to the Aluminum Research Laboratories at New Kensington, Pa. The building program will include a 2-story addition to the large testing laboratory for the purpose of housing a new testing machine, a 1-story extension to the present shop building, and a 3-story extension to the main building. The increase in floor space at 15,000 sq. ft. will bring the total to 71,000 sq. ft.

When the present buildings were erected about 10 years ago, they were built with eventual expansion in mind. The finished structure was to be in the form of a hollow square, with some buildings in the center court. The front of the square, parts of two wings, and court buildings were built at that time. The 3-story extension to the south wing of the present building will be divided as follows: The ground floor will be occupied by offices of the physical testing division and part of the instrument shop; the first and part of the second floor will provide new quarters for the patent division; the remainder of the second floor will be used for additional laboratory space. The space in the main building, vacated by the contemplated changes, will be used for rearrangement and expansion of other departments.

New testing machine, to be installed in the 2-story addition, will be able to exert a pressure of 3,000,000 lbs. in compression and 1,000,000 lbs. in tension. It will be one of the largest machines of its kind in the country and 10 times as large as the largest testing machine now in use at New Kensington. The entire expansion program will be completed by Jan. 1, 1940.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Chemist - metallurgist, University graduate, 6 years ferrous and non-ferrous experience in physical, chemical and metallurgical inspection of automotive and aircraft engines. 1 year as hard chrome plater and considerable research work done on magnet alloys. Complete knowledge of the metallurgical aspects of ferrous and non-ferrous alloys with ability to take photomicrographs and understand micrography of said alloys. Can offer best of references. Prefer midwestern territory. Box MA-158.

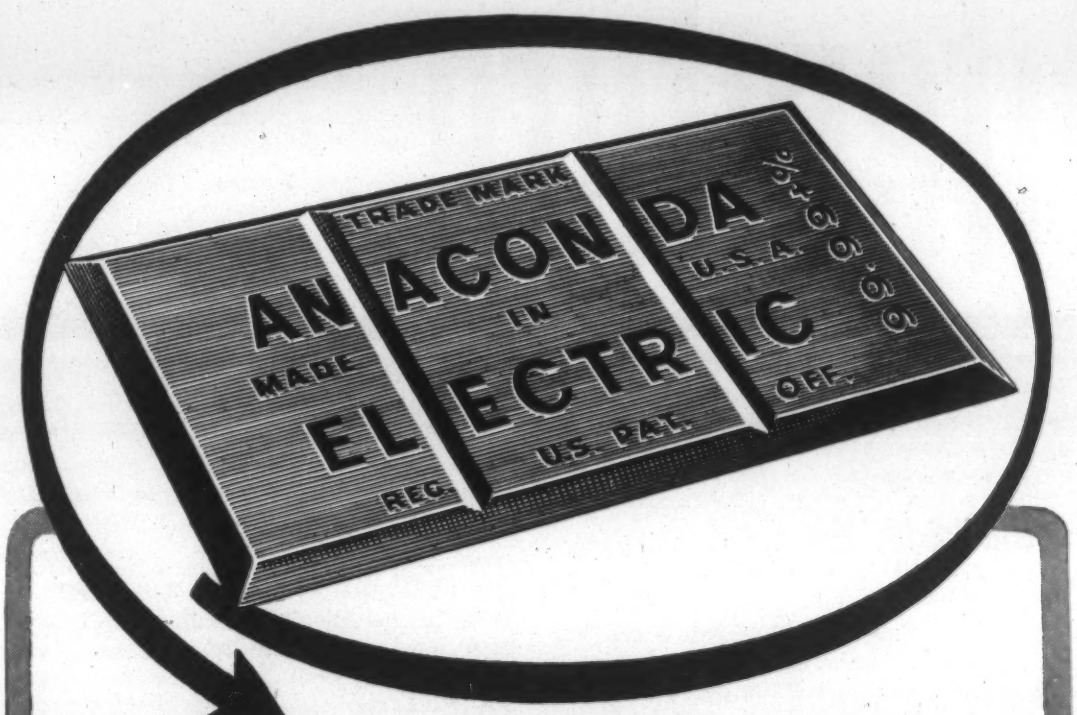
POSITION WANTED: Metallurgical Engineer. Extensive experience in all phases of application and fabrication of corrosion, heat resisting, and alloy steels desires position with fabricator or manufacturer as research engineer or engineer of tests. Inspection, preparation of specifications, also sales and promotional experience. Ph.D. Married. Prefer Eastern location. Box MA-159.

HELP WANTED: Metallurgist for manufacturer of ferro-alloys wanted. Good experience in both electric furnace and alumino-thermic process required. Box MA-160.

POSITION WANTED: Powder metallurgist—B.S. '37. Ch.E. '38. One year experience as powder metallurgist dealing with hot compression of powdered carbides. Half year experience as research assistant to professor of large Eastern university. Trained analyst. Available immediately. Single, 25. Eastern location preferred. Box MA-161.

POSITION WANTED: Chemical Engineer 1938. Publication on electrolytic lead. One year's experience as electrometallurgist and research assistant at large Eastern university. Desires research and development position in field of non-ferrous metallurgy. Excellent training in physics and chemistry. Honor societies. Available immediately. Eastern location preferred. Box MA-162.

POSITION WANTED: Metallurgist desires technical sales position. Employed, and for the past eight years, by nationally prominent manufacturer. Experienced in all phases of heat treating, physical testing, processing, fabrication, application and production of plain carbon, alloy and tool steels. Box MA-163.



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Yours for the Asking

1. FERROUS METALS

Vanadium Steels

The August issue of *Vanadium Facts*—a periodical publication of Vanadium Corp. of America—discusses the use of vanadium steel in ice skate runners, in Simplex jacks, and in large spindle forgings. (1-48)

Stainless Steel Stock List

A handy 16-page stock list (No. SS100) has been issued by Crucible Steel Co. of America and shows the sizes of Rezistal sheets, bars and welding rods carried in this company's mills and 26 branches. (1-49)

Sponge and Powdered Iron

The technical advantages of Swedish sponge iron as a steel-making raw material are set forth in a research publication of the Bureau of Mines, available from Ekstrand & Tholand, Inc. (1-8)

Nitriding Steels

The Nitralloy Corp. has just issued a 29-page engineering booklet (prepared by Dr. Homerberg) that covers in complete detail the whole field of nitriding—suitable steels, condition of steel, the nitriding process, applications in industry, published literature, etc. (1-33)

New High-Strength Steel

This little book gives facts and figures on DYN-EL, a new high strength, flat rolled steel claimed to have unusual resistance to fatigue, impact and corrosion. Complete fabricating and design properties and table of sizes and weights are included. Alan Wood Steel Co. (1-1)

Speed Case Steels

Data on the three new types of this company's "Speed Case" steel in the higher carbon ranges are offered by Monarch Steel Co. (1-7)

Stainless Steel Magazine

A new bi-monthly periodical—*Steel Horizons*—devoted to stainless steel, is published by Allegheny Ludlum Steel Corp. Each issue is beautifully illustrated, and contains full-length articles on new stainless steel applications and developments. (1-42)

New High-Strength Steel

Complete mechanical property data on a new low-alloy, high strength and ductile steel, are given for strip, plate and bars in a folder of Great Lakes Steel Co. (1-2)

2. NON-FERROUS METALS

Tungsten, Molybdenum and Alloys

The versatile experience and varied line of products of Callite Products Co. are featured in a bulletin describing special refractory Callite alloys, carbides and other unusual metallurgical products. (2-49)

Thermostatic Bi-Metal

Complete information on Dole thermostatic bi-metal, in the form of spirals, coils, strips, sheets, prefabricated parts or complete assemblies is offered by Dole Valve Co. (2-50)

Extruded Special Bronzes

Engineering data sheet No. 68 of Ampco Metal, Inc., announces that Ampco metal—wear resistant bronze available usually in cast form—can now be had also in extruded rods. Properties are given. (2-48)

Electrolytic Zinc

The importance of electrolytic zinc as a modern metallurgical material is indicated in literature from this company. Data on grades and prices are included. United States Smelting, Refining and Mining Co. (2-22)

Metal Hydrides

Reprints of a series of articles by P. P. Alexander on "The Hydride Process," in METALS AND ALLOYS, are available. History, production and the uses of metal hydrides are discussed. Metal Hydrides, Inc. (2-6)

New Copper Alloy

Mallory 333 metal, a new copper-chromium-lithium alloy, described as combining hardness with high conductivity, is useful for welding electrodes and other applications, according to a bulletin of P. R. Mallory & Co. (2-34)

3. CASTINGS • FORGINGS

Alloy Castings for Severe Service

Chromium-iron, chromium-nickel and nickel-chromium castings for resisting heat, corrosion and abrasion are comprehensively discussed in a well-illustrated 7-page bulletin of Duraloy Co. (3-7)

Forgings

This attractive 36-page catalog gives specific examples of applications and design of forgings, and discusses forging processes, finishing operations, inspection and metals used in forging. Much practical metallurgical information is included. Steel Improvement & Forge Co. (3-20)

Non-Ferrous Castings

Mechanical properties, composition and uses of 30 cast non-ferrous alloys, with machinability data for several, are given in a 6-page folder of Hills-McCanna Co. (3-16)

Heat Resisting Alloy Castings

Data on applications are given in a bulletin dealing with installations where strength at high temperatures must be provided. Ohio Steel Foundry Co. (3-3)

Special-Process Iron Castings

Meehanite Metal is described in full in a bulletin that gives engineering comparisons of this product with gray iron, cast steel and malleable. Meehanite Metal Corp. (3-21)

4. MELTING • REFINING • CASTING

(See also Section 6)

Refining Slag for Non-Ferrous Melting

Bulletin No. 308 gives the composition, general instructions for use, and directions for use with various furnaces of Purite. This product is stated to reduce metal shrinkage and casting losses and to improve general quality by forming a protecting and refining slag. Mathieson Alkali Works. (4-8)

Electric Melting Furnaces

Copiously illustrated 18-page bulletin discusses applications of electric melting furnaces in general and types, salient features, typical installations and practical advantages of Heroult furnaces in particular. American Bridge Co., United States Steel Corp. Subsidiary. (4-13)

Foundrymen's Periodical

The *Whiting Founder*, a regularly-issued magazine containing illustrated articles on foundry practice, will be sent to interested foundry executives. Whiting Corp. (4-21)

books

Metallurgical Bible

METALS HANDBOOK—1939 EDITION. *Published by American Society for Metals, Cleveland. Cloth, 5¾ x 8¾ in., 1803 pages. Price to non-members $12.50.*

The Handbook is getting too large for comfortable use, so one hopes that the next edition will come in two volumes instead of one. The present volume contains 1200 pages of ferrous data to 600 of non-ferrous.

Naturally a good deal of the contents is not materially changed from that of the 1936 edition, yet an astonishingly large proportion, even of the sections on topics that one would expect to be venerable enough to require little modification, has been rewritten and many entirely new sections have been added. Almost every section has been prepared by a special subcommittee of experts on that particular topic, or when the section is prepared by an individual, he is one with a good knowledge of the subject but not affiliated with a commercial interest. Representatives of commercial interests were, of course, utilized as cooperators but were not allowed to run the show. Thus sections that could be stigmatized as axe-grinding write-ups are remarkably rare. Since the authors are thus restricted to engineering facts, with propaganda barred, it is surprising how many people have been able to spend their firm's time in preparation, evaluation or revision of material for the handbook. The result is clear indication that a lot of people are really interested in making reliable information readily available.

The scope of the handbook is so great that one tends to expect to find a pretty good introduction to almost any topic in metallurgy, plus a carefully selected bibliography, and this expectation is raised by finding good discussions of such topics as use of statistical methods, effect of nonmetallic inclusions, and many other subjects that require much more than the tabulation of a few data. However there are still omissions, such as the lack of a general discussion of wear, of damping, of a discussion of the status of the Hazelett and similar direct forming processes, of discussion of phosphate coatings, of rail steel, or of copper-lead and cadmium-silver-copper bearing metals. A rather astounding omission is the lack of anything beyond a non-informative mention of controlled atmospheres for heat treatment. The preparation of new sections goes on continually, so some of these may be already in process of preparation for the next edition.

Despite the fact that the handbook is no encyclopedia in which one may properly expect to find summarized all metallurgical knowledge, it comes the nearest to it of any single publication. Analogous German handbooks are not even within hailing distance for completeness or utility. It is a book that every metallurgical engineer will keep within arm's reach and to which he will turn more often than any other single source of information on testing, alloy constitution, properties of alloys and methods of heat treatment. The preparation of so comprehensive, authoritative and practically useful a handbook is a service to the metallurgical fraternity that overshadows any of the other attempts of the A. S. M. to benefit its members. Credit for the nonferrous section is equally due to the A. I. M. E. The labor of preparation of that section was borne by a few scores of wheelhorses instead of being distributed among literally hundreds of cooperators as was the case in the ferrous section.—H. W. GILLETT.

Machine Design

MACHINE DESIGN. *By Stanton E. Winston. Published by American Technical Society, Chicago, 1939. Cloth, 6 x 8½ in., 333 pages. Price $3.00.*

This is an elementary text book, with chapters on simple stresses, compound stresses, bolts and screws, cylinders and riveted joints, shafting and keys, couplings and clutches, pulleys and the like, friction and gear drives, and miscellaneous details. Each chapter is concluded with many examples to be worked by the student.

Since this is sent to a metallurgical journal for review, one may assume that either the author or the publisher considers that the volume has enough metallurgical value to warrant a favorable opinion from a metallurgical reviewer. It is a pity that the metallurgical aspect was not thought of earlier, so that some colleague of the author who is acquainted with metallurgy or materials of construction might have cast a friendly eye on the manuscript, or, failing this, that the publisher might have had it read by someone with some metallurgical background.

Looking at the volume from the metallurgical point of view, one wonders why so much on riveting with nothing on welding, and how a professor can justify dealing with keyways without saying anything about stress concentration or fatigue.

Table 1 lists "average" tensile, compressive and shear strengths for some materials of construction. In this, cast iron and cast aluminum are given at 20,000 and 13,000 lbs. per sq. in. tensile, respectively, as though no better materials were available in either class; medium steel (0.15-0.40 per cent C) and hard steel (0.30-0.70 per cent C) at 60,000 and 75,000 lbs. per sq. in. tensile respectively, raise the question of what the poor student would do if he happened to have a 0.35 per cent C steel, and 3.5 per cent Ni steel is listed at 90,000, molybdenum steel at 140,000, and silicomanganese steel at 250,000 lbs. per sq. in. without even a footnote to indicate what heat treatment is involved. The student is not told to look up properties in any text or handbook on materials, but is given such figures as "averages."

On page 274, safe stresses to be substituted in a spur gear formula are given for cast iron, semi-steel, cast steel and "chrome nickel."

Naturally, this is not a book on strength of materials and in the examples to be worked the student is told the strength to assume in working the example. But if such tables are to be included at all, why should they be given in terms that any freshman student of materials of engineering knows are laughable? This is exactly the same sort of carelessness that was met in another text book written a year or so ago by a professor at another university. If book-writing professors won't consult their colleagues when they must include reference to matters on which they are ignorant, Deans of Engineering ought to rise up and demand that consultation be had for the good of the name of the institution. Since the book is advocated by the publishers for home study, the alibi can't be raised that a student will have had a course in materials, and so will know better.

The publisher says the binding is waterproof and verminproof. Well, that's something, anyway.—H. W. GILLETT.

Advertisers' Index

Air Reduction Sales Company ..... A 15
Ajax Electric Company Inc. ..... A 13
Ajax Electric Furnace Corporation ..... A 13
Ajax Electrothermic Corporation A 13, Outside Back Cover, MA 581
Ajax Metal Company ..... A 13
Alan Wood Steel Company ..... A 61
Alrose Chemical Company ..... MA 610
Aluminum Company of America ..... A 38, A 39
American Brass Company ..Insert between pages A 40 & A 41
American Bridge Company ..... MA 582
American Car & Foundry Company ..... MA 586
American Chain & Cable Company, Inc., Page Steel & Wire Division ..... MA 603
American Chemical Paint Company ..... MA 607
American Cyanamid & Chemical Corporation ..... MA 589
American Electric Furnace Company ..... A 77
American Gas Association ..... MA 598
American Gas Furnace Company ..... A 70
Anaconda Sales Company ..... MA 627
Andrews Steel Company ..... MA 571
Arcos Corporation ..... MA 604
Armstrong Cork Company ..... MA 592, MA 593

Babcock & Wilcox Company ..... Inside Front Cover
Baker & Company, Inc. ..... MA 600
Bausch & Lomb Optical Company ..... A 47
Brown Instrument Company ..... MA 595
Buehler, Adolph I. ..... A 41

Callite Products Division, Eisler Electric Corporation ...MA 620
Carborundum Company, Globar Division ..... A 79
Carborundum Company, Refractory Division ..Inside Back Cover
Carnegie-Illinois Steel Corporation ..... A 2, A 3
Chicago Flexible Shaft Company ..... MA 584
Cleveland Twist Drill Company ..... A 69
Climax Molybdenum Company Insert between pages 324 and MA 569
Columbia Steel Company ..... A 2, A 3, MA 582
Crucible Steel Company of America ..... MA 587

Dempsey Industrial Furnace Corporation ..... MA 600
Detroit Rex Products Company ..... MA 575
DeWitt Operated Hotels ..... MA 606
Dole Valve Company ..... MA 621
Dow Chemical Company, Dowmetal Division ..... A 6
Driver Company, Wilbur B. ..... MA 621
duPont de Nemours & Company, E. I., R. & H. Chemicals Department ..... MA 574
Duraloy Company ..... A 35

Ekstrand & Tholand, Inc. ..... A 74
Electric Furnace Company ..... A 67
Electro Metallurgical Company ..... A 63
Electroloy Company, Inc. ..... MA 602

Fitzsimons Company ..... MA 585
Foote Mineral Company ..... MA 602
Foxboro Company ..... MA 596, MA 597

General Electric Company ..... MA 591
General Electric X-Ray Corporation ..... MA 612
Great Lakes Steel Corporation ..... MA 619

Handy & Harman ..... A 31
Hardy, Inc., Charles ..... A 33
Hayes, Inc., C. I. ..... A 11
Hevi Duty Electric Company ..... A 4
Hotel Adelphia ..... MA 620
Houghton & Company, E. F. ..... A 78

Illinois Testing Laboratories, Inc. ..... A 36
International Nickel Company, Inc. ..... A 80, MA 577

Jarrett, Tracy C. ..... A 42
Johns-Manville Corporation ..... MA 581, A 82
Jones & Laughlin Steel Corporation ..... MA 572, MA 573

Kemp Manufacturing Company, C. M. ..... A 53
Kenworthy, Inc., Charles F. ..... MA 594

Leeds & Northrup Company ..... MA 578
Lincoln Electric Company ..... A 49

McKenna Metals Company ..... MA 586
Mallory & Company, Inc., P. R. ..... MA 605
Maurath, Inc. ..... A 51
Meehanite Metal Corporation ..... A 8
Metal Hydrides, Inc. ..... A 29
Metals Disintegrating Company, Inc. ..... A 75
Minneapolis-Honeywell Regulator Company ..... MA 595
Monarch Steel Company ..... MA 585

New Jersey Zinc Company ..... A 25
Nitralloy Corporation ..... MA 623
Norton Company ..... A 45

Ohio Crankshaft Company ..... A 55
Ohio Steel Foundry Company ..... A 43
Olsen Testing Machine Company, Tinius ..... A 71

Page Steel & Wire Division, American Chain & Cable Company, Inc. ..... MA 603
Pangborn Corporation ..... A 21
Pennsylvania Salt Manufacturing Company ...MA 608, MA 609
Physicists Research Company ..... MA 615
Pike & Company, E. W. ..... MA 616
Pittsburgh Lectrodryer Corporation ..... MA 594
Pittsburgh Lectromelt Furnace Corporation ..... MA 581
Pyrometer Instrument Company ..... MA 581

Rockwell Company, W. S. ..... A 57

St. Joseph Lead Company ..... MA 570
Scomet Engineering Company ..... A 30
Scott Company, Henry L. ..... A 17
Spencer Turbine Company ..... A 40
Sulmet Alloys Company, Inc. ..... A 65
Surface Combustion Corporation ..... A 73

Taylor Sons Company, Charles ..... MA 590
Thermal Syndicate, Ltd. ..... MA 624
Timken Roller Bearing Company, Steel & Tube Division ..A 22
Titanium Alloy Manufacturing Company ..... A 27

Union Carbide and Carbon Corporation ..... A 63
United States Smelting, Refining and Mining Company ...A 37
United States Steel Corporation ..... A 2, A 3, MA 582
United States Steel Products Company ..... A 2, A 3, MA 582

Vanadium Corporation of America ..... A 59

Westinghouse Electric & Manufacturing Company ..... MA 599
Wilson Mechanical Instrument Company ..... MA 613

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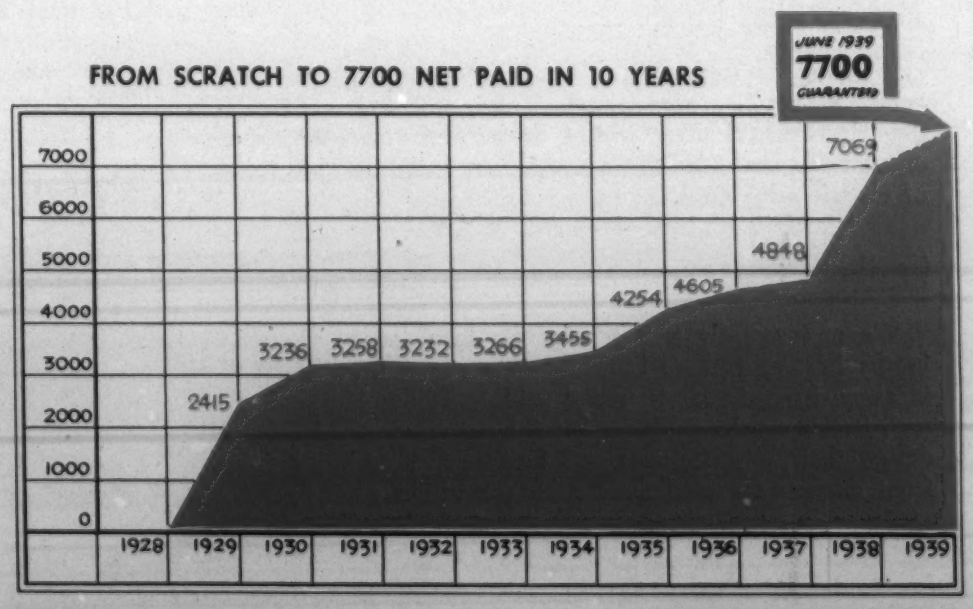

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Metals and Alloys

The Magazine of Metallurgical Engineering

330 West 42nd St.
New York, N. Y.

trends

By Edwin F. Cone, Editor

Trends in a Decade

The trends in metallurgical engineering progress in the last 10 years have been numerous and striking. We wish we could point them out here individually, but if our readers will consult the array of 10-year reviews published in the Preview Section of this issue, they will find significant trends discussed—with some prognostications as to the future. There is a wealth of information in them.

Permanent Magnets

The trend in the development of magnetic alloys or permanent magnets has been and still is an interesting one. An article in this issue tells the metallurgical story of the "Alnico" type, as well as some facts regarding the trend to new alloys. In our 10-year review, Dr. Brace calls attention to some important trends in this field and mentions a 77-per cent Pt-Co alloy of remarkable properties.

Machine Tools

In our September issue and in this one is an article on the "Role of Nickel in the Machine Tool Industry" by two men very closely associated with this large industry. They show the extent to which the trend in building these machines is away from the plain cast irons and steels and toward the alloyed materials.

Electric Alloy Steel

A newspaper report from Pittsburgh states that the Copperweld Steel Co., near Glassport, Pa., will erect a $2,000,000 electric steel plant with a capacity of 100,000 tons of alloy steel a year—another sizeable item in the upward trend of electric alloy steel.

Heating Furnaces

We met recently a man who for many years has been in the heating furnace business. He stated that the trend is away from firms designing and building (furnishing) such furnaces—the tendency is for large companies to either design their own furnaces and build them, or build them from designs obtained from such consulting engineers.

Selective Induction Hardening

Extensive progress is being made in the selective hardening of steel by the "Tocco" process. Many non-cylindrical shapes, it has been demonstrated to us, can now be hardened by induction heat. The first application, it will be recalled, was to crankshafts.

Safety in the Steel Industry

The trend towards safety in the steel industry is decidedly upward. In 1937 the industry ranked fifth, having risen from twelfth in the preceding 3 yrs. During 1938 the steel industry improved its safety record by more than 20 per cent and rose to the rank of the third safest among 30 leading industries, according to a study by the American Iron and Steel Institute.

Ag in Mg Alloys

Alloying of magnesium with silver seems to have considerable promise on the basis of experiments in this country and in England. About 5 per cent Ag with a little Al-Zn and Mn raises the tensile strength to more than 60,000 lbs. per sq. in. with a yield strength of about 50,000 lbs.

Tons of Steel per Capita

Tons of steel per capita in the U. S. is mounting rapidly, according to an impressive chart of metal in the U. S. Steel Corp. Building at the New York World's Fair. From 1½ tons per capita in 1901, the figure has advanced about 2 tons every 10 yrs. In 1930 it was 5½ tons and in 1939 it is put at 9½ tons per capita. In 1800 it was 1710⅔ lbs. and in 1850 only 130 lbs. per capita.

Redesigning Car Trucks

Due to the trend to greater speed of freight trains, car trucks are being redesigned. This is likely to result in the more extended use of alloy steels, both wrought and cast, to cut down weight with no sacrifices of, and probably some increases in, strength.

Ferroalloys from Electric Furnaces

In recent years statistics of the American Iron and Steel Institute have been giving the quantity of ferroalloys made in electric furnaces. In 1938 the 247,853 gross tons of ferroalloys from electric furnaces was about 40 per cent of the total ferroalloys made, including ferromanganese and spiegeleisen from blast furnaces. In 1937 the corresponding ratio was 36.8 per cent for the electric furnace product. The tendency is greater use of electric ferroalloys.

Magnesium Structural Alloys

Magnesium is becoming one of our important structural materials. According to Bregman in *The Iron Age,* June 29, about 1,000,000 lbs. of magnesium structural products —castings, sheet, structural shapes, rods, tubes, forgings, etc.—were manufactured. In 1937 these products totalled over 1,400,000 lbs. The total American magnesium production that year was more than 4,500,000 lbs. The trend towards magnesium structural products is decidedly on the increase.

New Equipment and Materials

Brinell Machine

Of particular interest to those Brinell testing large and awkward parts such as castings, forgings, etc., is a new Brinell machine recently placed on the market by the Detroit Testing Machine Co., Detroit, Mich. In using machines previously available considerable difficulty is experienced in positioning the part on the top of the screw table and in adjusting the screw for different sizes of work.

The new machine is claimed to eliminate this by having a large stationary table and a ram sufficiently long to cover the range of the machine. The work is simply placed on the table and the ram carrying the test-ball brought into contact with it.

Operation is controlled by a lever on the side of the machine and the ram may be stopped in any position. Thus, when several pieces of the same size are to be tested, the ram is raised only enough to remove and insert the work. Movement of the lever rapidly adjusts the ram for work of different sizes. This takes less than 10 secs. from one extreme to the other. While the ram movement is rapid the actual test is applied at a relatively low speed, thus avoiding impact errors. Operation also is hydraulic throughout and a fractional h.p. ball-bearing motor drives the pump, the shaft of which is also ball-bearing mounted. All working parts are bathed in oil, insuring long wear and minimum of maintenance.

Two standard sizes are available: No. 1 has a throat depth of 6 in., maximum height 12 in.; table 12 x 20 in. No. 2, throat depth 9 in.; maximum height 18 in.; table 17 x 24 in. The company is prepared to build special machines to any dimensions.

Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts not more than 2 in. wide.

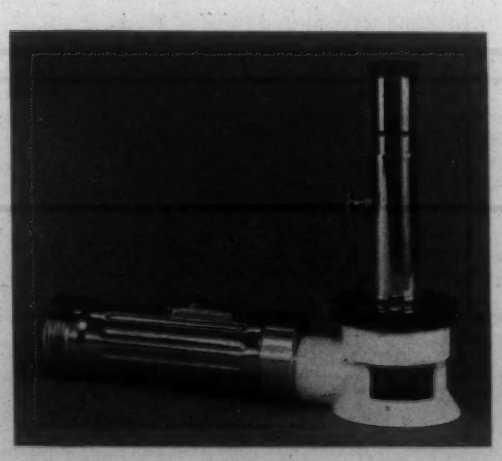
Illuminated Portable Microscope

The Bausch & Lomb Co., Rochester, N. Y., has added to its Wide Field Tube a "Flash-O-Lens," made by E. W. Pike & Co., Elizabeth, N. J., and in this way, it is pointed out, the user has a really fine illuminated portable microscope, which has a thousand and one uses in the shop, factory and laboratory. It can be used in the darkest corner of the plant. With a working distance of about 2 in., it permits, however, the observation of work carried on several inches from the objective lens. Surfaces can be examined most conveniently.

The special adapter used holds the tube at the proper distance, and a locking nut maintains the focus while observing different areas. Whenever the work demands more careful observation, greater working distance and higher power of magnification than afforded by the regular Flash-O-Lens, the Wide Field Tube will prove of value.

The instrument is used in the trades for examining raw materials—castings, welds, screw holes, etc.—as well as laying out fine work. The instrument has a high eye-point position, enabling the wearer of glasses to observe the entire field without discomfort. It forms an inverted and reversed image as does the ordinary monobjective microscope. Magnifications from 6.01 to 20 X are available.

In the B. & L. Shop Microscope, a magnification of 40 X is available, also in this instrument is contained an engraved scale mounted in the body tube which reads directly to thousandths of an inch. Estimations can easily be made to 0.00025 in.



Improved Spray Gun

A greatly improved and patented spray gun, constructed of Dowmetal, incorporating strength with extreme lightness and identified as Model "BC" Series No. 12 is being featured by the Willard C. Beach Air Brush Co., Harrison, N. J. Because lightness as well as strength is of extreme importance to users of all portable tools, this new Beach spray gun reaches new highs in customer appreciation and satisfaction, it is claimed. In addition to the advantages outlined, Dowmetal was selected for this use because of its ready machinability and because sand castings can be produced without die-forging expense.

Concerning the assembly and finishing of this gun, a number of other important advantages are claimed. The low density of Dowmetal permits a large gun grip and perfect

balance without coring. The thread seizure is also considerably less than with dissimilar metal parts. In addition, this magnesium alloy metal permits a very successful seating of the air valve. As to costs of production it is stated that they are exceptionally reasonable for the many advantages obtained both for the manufacturer and the user.

It is interesting to note the comparative weights of spray guns Beach has manufactured of various materials. They indicate the constant progress that has been made in modernizing this product. A Beach gun constructed of bronze back in 1926 weighed without parts 893.3 gr. A forged aluminum gun of more recent origin, also without parts, weighed 381.7 gr., while this new Dowmetal gun exclusive of parts weighs only 287.7 gr.

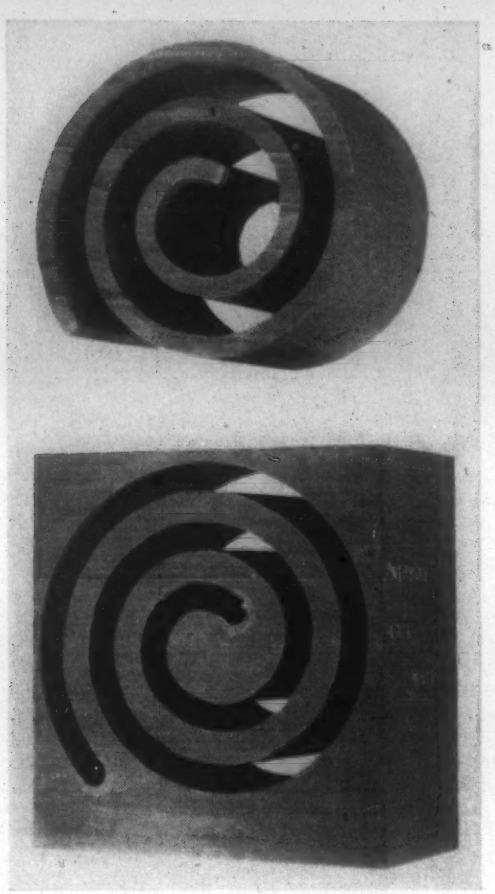
A Resin Cement

"Korez", a new impervious syntheic resin cement, has been developed by The Atlas Mineral Products Co., Mertztown, Pa. Korez is applied as a mortar which quickly sets by chemical action at room temperature to a dense, strong, jointing material, it is claimed.

Being impervious and inert to all acids, except the highly oxidizing ones, and inert to oils, water, and mild alkalies at temperatures up to 330 deg. F., this resin cement is said to have solved many difficult corrosion problems in steel plants, chemical plants, refineries, and in the food industries.

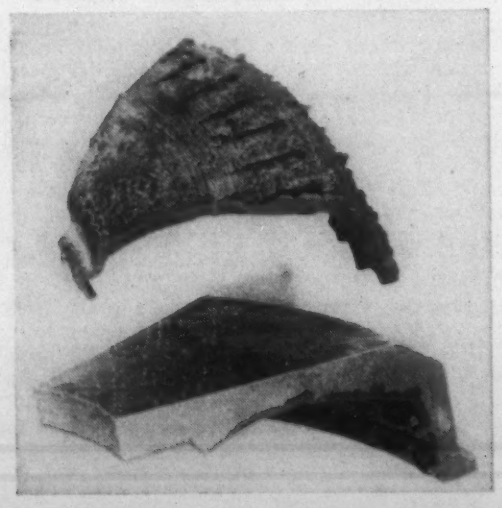
Electroforming With Iron—The "Ekko" Process

The "Ekko" process is a new method for the preparation of molds and dies which grew out of researches by the United States Rubber Co., New York, on the production of cheaper tire molds. During the course of this development but before tire molds were an accomplished fact, it became obvious that the Ekko method offered advantages to almost all industries using molds and dies. The molds and dies thus produced effect savings for the customer or permit him to produce more ornate and attractive articles hitherto prohibited by tool costs, it is claimed.



The application of Ekko to other than tire molds was investigated with increasing interest and success until early in 1939 when it was decided to establish within the United States Rubber Co., a department making these products available to industry at large. The Detroit plant was chosen as the site for this work as all of the original development had been done there.

The Ekko process produces molds and dies by electroforming iron against a pattern it is desired to reproduce. Electroforming is the same as electroplating except that deposits up to ½ in. thick are produced. Electroplating is used for decorative purposes or to provide corrosion resistance while electroforming is used to build up a mass of metal.

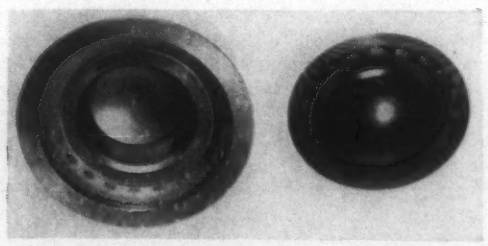


When heavy electroformed deposits of iron are separated from the underlying pattern, a cavity or die insert is obtained which has reproduced the shape and surface finish of the pattern in every detail; this cavity or die, when properly mounted, may be used to mold or stamp objects the exact shape of the original pattern, it is said. The name Ekko is a phonetic spelling of "echo", suggestive of the duplicating nature of the process.

In the preparation of tire molds, the mold is made by the usual process of engraving where the tread design and cavity are cut out of a steel forging (or casting) with special engraving machines. The steel forging is later mounted in a cast iron back called a watch case. These molds weigh around 600 lbs. and require at least 165 man hours labor to produce. One mold is produced by engraving and reproduced as many times as desired by electroforming. The engraved mold, after the addition of a spacer ring, is used to mold the pattern which is later covered with iron by electrodeposition. The pattern is rendered conductive by dusting it with powdered graphite and polishing it vigorously with a light brush. The polishing operation is said to add to the finish obtained on the electroformed cavity. An illustration shows a section of an electroformed cavity grown to a thickness of ⅜ in. and separated from the pattern. The roughness on the outside of the shell is characteristic of heavy electrodeposits. The finish inside the cavity is described as identical with that of the pattern from which it was obtained. The electroformed tire mold can be made at a considerable saving over the engraved mold, it is said, because it requires considerably less labor.

The iron produced by the electroforming process is 99.88% pure and substantially free from porosity. When plated it is about 50% harder than cold rolled steel and gives a scleroscope reading of 37 or a Brinell of 240. The metal can be softened to the normal value of pure iron by annealing or can be hardened by carburizing so that it will scratch glass, according to the company. Electrolytic iron has a heat conductivity nearly twice that of cast iron or steel. This is a special advantage in molding operations where a high rate of heat transfer is desirable. Patterns upon which to deposit the iron need not be of rubber as in the preparation of tire patterns. Provided the surface is made conducting, wood, glass, plastics, or similar materials may be used; any metal is satisfactory with the exception of zinc and aluminum which are attacked by the plating bath.

The simplest case of other uses is that of the radio dial. Using a bakelite radio dial as a pattern the cavity was electroformed. The plated metal is approximately ¼ in. thick and can be mounted for use by machining the back to a suitable shape and inserting the electroformed cavity into a steel block which has been hollowed out to receive it. The other half of the mold can be prepared and mounted in the same manner. The dial scale and numbers are raised in the mold, a condition which is difficult and costly to obtain by engraving. By the electroforming process raised letters can be produced as easily as those depressed below the surface, it is claimed.



Safety Goggles

All its "Ful-Vue Safety Goggles," American Optical Co., Southbridge, Mass., announces, will shortly be supplied with a new, improved type of bridge (nosepiece)—and also in a new range of 3 eye and 3 bridge sizes.

The new double-braced bridge, soldered at 4 places to the lens-frame instead of the conventional 2 permitted by ordinary bridges, is an exceptionally sturdy design that assures long service under hard use. The added rigidity, resulting from the longer bearing surface of the bridge on the lens-frame, means that the goggles will stay in proper adjustment longer, under the most strenuous daily handling, and even under impact. In addition, the modern styling and decorative milling of the bridge are said to definitely improve the entire appearance of the goggles.

To secure more exact fitting of the goggles to individual workers, they will be supplied in 3 eye sizes (44, 47 and 50 mm.) and 3 bridge sizes (21, 23 and 25 mm. between lenses).

The "Doall 26"

Continental Machines, Inc. of Minneapolis, were to have introduced their new "Doall 26" at a special showing in Cleveland, between Oct. 4 and 13. The new machine has a 26-in. throat depth. The company now offers Doall machines with capacities of 16, 26 and 36 in. The new Doall 26, like all Doalls, is of rugged, arc welded steel construction, thus making possible the modern streamlined appearance of the machine.

Capacities in this new model have been greatly increased. It has a 30 by 30-in. large work table, having the strongest box type construction. The machine can employ precision band saws of any width from 1 m.m. up to and including 1 in., whereas previous models accommodated band saws up to ½-in wide. The machine will, also, employ a new ½-in wide file band in addition to the ⅜-in. wide and ¼-in. wide file bands.

A newly designed automatic power work feed is one of the features of this machine. It not only exerts pressure into the saw, but throughout the contour as well. Any curve can be cut by hand wheel control. No hand pressure is required for any type of cut. The spiral cut-out shows the results of this new automatic feed. This spiral part cut from 2½-in. thick forging steel was machined with the feed in only 1 hr. and 48 min. The automatic feed greatly amplifies the machines work capacity, it is said. The machine table can be inclined in any direction, forward, rearward or sideways. The maximum tilt is 45 deg., permitting the cutting of any angle. Another feature is the frictionless cutting attachment which is said to permit easy machining of heavy work. Improvements have been made in almost all of the assemblies of the machine. with the idea in mind of providing easier operation on a wide range of work. The machine is massive and rugged. It weighs over 2,000 lbs. A 1½-hp. motor drives the machine through the company's Speedmaster molded bakelite variable drive and through a silent transmission. Two new machining processes made possible by the redesigned Doall machines were to have been exhibited at the company's booth at the Machine Tool Show in Cleveland. A method of making "stampings" without dies and the production of short run "forgings" were among the exhibits. Large capacity and sturdy precision construction are claimed to give the new Doall 26 a capacity for a wide range of work and to make possible new machining methods.

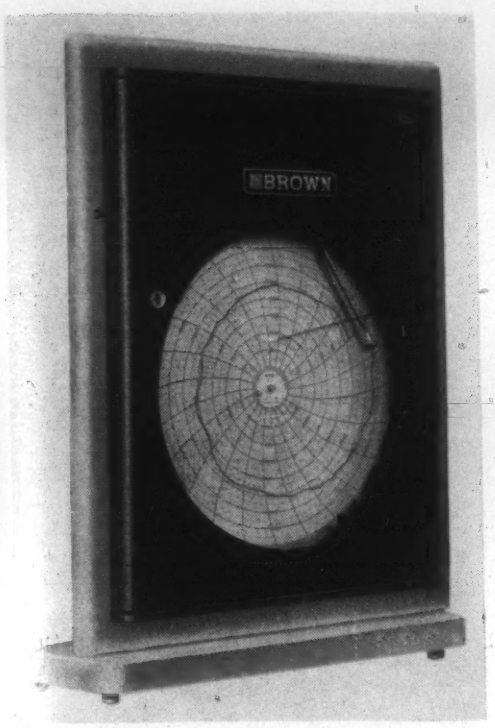
Handy Forgings Weight Calculator

The Kropp Forge Co., 5301 W. Roosevelt Road, Chicago, has had prepared a handy calculator for rapidly determining the weights of forged square, round, hexagonal and octagonal flats and bars and forged rings and blanks. No computation is said to be necessary. It is only necessary to know the dimensions of any of the forged shapes covered by the calculator to instantly determine its weight. These Kropp forgings weight calculators are available at a small charge to partially cover the cost of producing and mailing.

Thermometer and Pressure Gage

An entirely new and improved line of temperature and pressure recorders, indicators and controllers has just been placed on the market by The Brown Instrument Co., Philadelphia. These instruments include thermometers indicating and recording types for temperatures from —40° F. up to 1200° F.; and indicating or recording pressure and vacuum gages for ranges from 6 lbs. of water up to 2500 lbs. per sq. in. and on vacuum ranges of 10 in. of mercury and over. All types are offered in 1, 2 or 3 pen models—the result of years of research and field testing under actual operating conditions by Brown engineers.

The powerful, flat, spiral actuating elements are described as having ample pen torque without sacrificing speed of response. Especially heat-treated to insure permanent calibration, they have exceptional over-range capacity. A



special safety link between actuating element and pen provides an overload safeguard protecting the mechanism from damage if the pen is moved in either direction manually. The chart is firmly secured to the driving mechanism by tapered stud and tapered chart positioning stud, eliminating chart knob and chain. Charts, when renewed, are automatically in time, as the tapered position stud is in effect the hour hand of the electric clock. If current failure makes it necessary to reset chart to correct time line, a friction clutch permits manual rotation for chart setting. Other features include: (1) Pen shaft has sturdy outboard bearing, with hardened pivots, mounted on rigid casting; unaffected by vibration. (2) Longer pen arm, 8 in., permits pen travel of 4¾ in. Easily removed and replaced, with no effect on calibration, micrometer adjustment assures precision setting. (3) Resilient mounting—A rigid, flat sub-plate with 3-point resilient suspension mounting carries all moving parts. Insures permanent alignment, even though case mounting is distorted, accuracy is unaffected. (4) Chart clips, mounted on door, an integral part of shield which conceals operating mechanism. (5) Adaptor block—designed to permit easy removal of actuating element for replacement or change of range by user.

A new bulletin No. 2-17, completely describing this new line of instruments, has been issued and a copy will be sent promptly on request.

The Stationary Disintegrator

A stationary disintegrator, which can be accurately controlled, it is claimed, while carrying on the processes of absorption, condensation, fractionation, chemical reactions, heat exchange, gas and air washing, has been developed by the H. A. Brassert Co., 310 South Michigan Ave., Chicago, Ill.

Engineered, first, for gas washing in the steel industry it has been proved adaptable in other fields where an accurately controlled degree of contact between gases and liquids is desired. Air conditioning experts, for instance, baffled in their efforts to remove objectionable odors which occur as fume in some processes, are turning to the "Brassert Disintegrator" for an absorption job not possible by any other device of this type. Processes requiring the contacting of gaseous vapors with liquids can use the Disintegrator to improve and speed up this operation. Its fundamental construction is based on the principle of producing a concurrent flow of gas or air and of very finely divided liquid spray at high velocity through a venturi tube with impingement on a surface at right angles to the direction of flow. Standard rating is one disintegrator unit per 1000 cu. ft. per min. of gas or vapor measured at 60 deg. F. and atmospheric pressure.

The theory of this method of obtaining an efficient mixing of gaseous vapors with liquids has long been known, but "it remained for Brassert to work out a practical device with three basic features." The first is the development of an economical venturi throat having a capacity large enough to maintain a minimum amount of adjustment and accessories and at the same time maintain maximum efficiency with respect to the mixing of the constituents involved. The second feature is the arrangement whereby the relation between the venturi tube and the baffle plate can be adjusted from outside the tower. This adjustment controls the back pressure, and velocity of the gas, and can be changed at any time to obtain the magnitude of contacting which may be desired for a given operation. The third feature is the ability to remove and examine or replace the high pressure liquid nozzle in each unit without shutting down the whole operation. The volume and pressure of the liquid may be varied by either changing the high pressure nozzle or controlling the liquid pressure at the pump.

Wide operating range - just another important characteristic of the du Pont treating salts - whether they are to be used for carburizing, case hardening, re-heating, nitriding, coloring, tempering or drawing. Skillfully combined du Pont salts are designed to meet modern requirements for an economical and easy application.

Du Pont's trained technical and field staff will gladly assist you in the selection of the right salt for your particular requirements. Just call or write our nearest office.

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E. I. DU PONT DE NEMOURS & COMPANY (INC.)
The R. & H. Chemicals Department
Wilmington, Delaware

District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

Hardness Tester

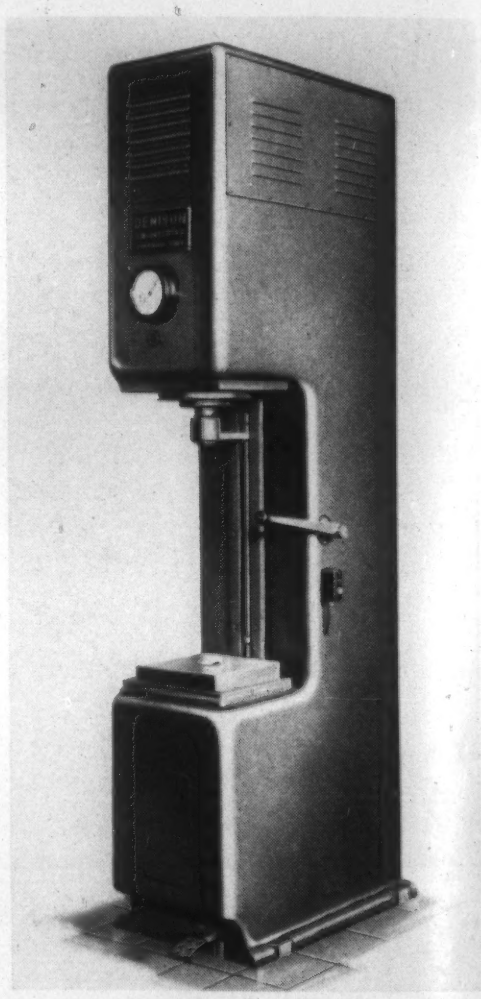
A new type hardness tester known as the "Steeltest" has been introduced by the Modern Collet & Machine Co., 401 Salliotte St., Ecorse, Mich. This instrument is described as particularly designed for volume hardness testing and as offering automatic features never before incorporated in equipment of this nature. It can be operated at 3 speeds and is capable of making 1200 to 2700 accurate hardness tests per hour. Direct readings on the "Steeltest" give actual hardness numbers in Rockwelling and Brinelling. There are no charts and no comparative readings. The readings appear on a standard 100-division dial, in all scales, and within the tolerance of standard test bars.

The operation of the "Steeltest" is almost entirely automatic, the only manual operations being the hand elevation, by operation with a removable crank, for the initial setting of one specimen in each batch run and the feeding of the specimens. The travel of the penetrator is fully automatic, and is synchronized with two flasher lights located directly below the indicating dial. The penetrator is encased in a housing which shields it from all possible damage. The nosepiece of the housing is designed with a guard so that the smallest parts may be tested without endangering the fingers. Dead weight minor and major loads are applied automatically and are positively constant, thus overcoming inaccuracies which arise through manual operation. Minor load is 10 kg.; interchangeable calibrated weights give major load of 60, 100, and 150 kg. The compensated loading beam gives a constantly equalized dead weight application through the entire stroke. There is no "pendulum swing" in the load, a most important factor in accurate application of minor and major loads. The power supply is 1/15 h.p. ratiomotor, 60 cycles, 110 volt A.C., arranged with a direct-coupled cam drive.

Denison Hydraulic Presses

Denison "Dlac 1 Vertical Hydraulic Presses" are claimed by the Denison Engineering Co., Columbus, Ohio, designed for increased efficiency of production on modern straightening, assembling, broaching and pressing operations. The frame is fabricated, electric-welded steel construction that combines modern eye-appeal with the utmost in strength and rigidity. All corners and edges of the frame are rounded, which greatly reduces the hazard of accident. Ample toe space for the operator has been provided beneath the frame at front. Careful attention has been given to the location and operation of the hand lever, and foot pedal.

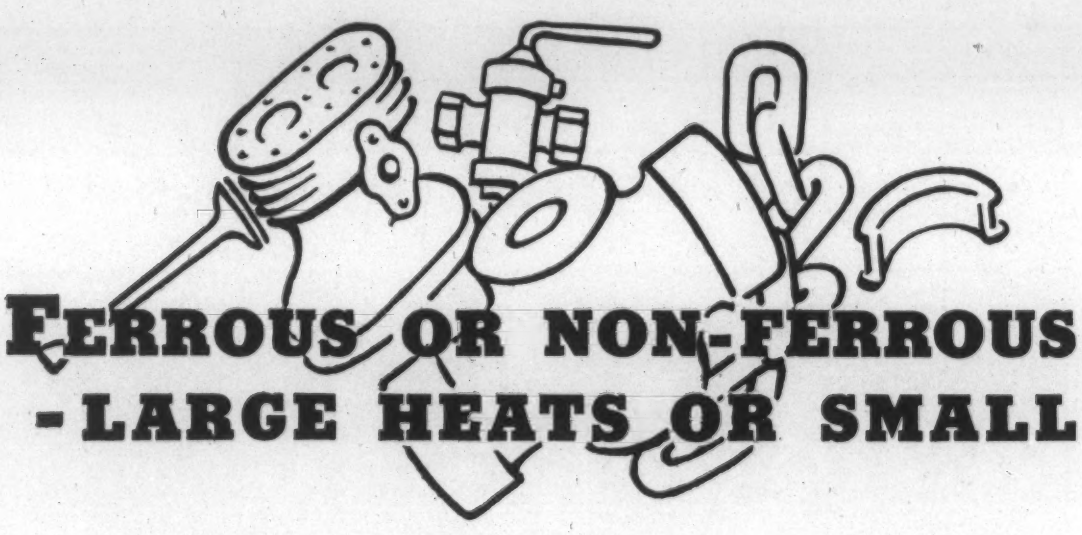
In general arrangement the press cylinder assembly consists of an accurately finished steel cylinder fitted with nickel-iron cylinder heads, piston, steel piston rod and self-sealing packing. Located in the upper part of the frame, behind the cylinder, is the hydraulic pump,



which is integrally flange-mounted on its driving motor. Under the motor compartment is the oil reservoir. A curved chute leads from the space beneath the hole in the rest plate to a door in the front of the press frame, so that tools and fixtures that may be pushed through can be reached easily. The ram is guided against rotation by machined alloy guides in the throat of the press. The magnetic motor starter and the pressure and directional controls of the press are located within the frame. The press is a complete unit. The entire rear panel is removable, leaving all parts accessible for maintenance or adjustment.

The operation of the press is such that normally, with both the foot pedal and hand lever released, the press ram rises to the limit of its upstroke, which is determined by adjustment of the set collar. The ram then stops, the pressure is released, and the pump and motor run idle.

Stepping on the foot pedal or operating the hand lever causes the ram to move down until either the ram contacts the work with full pressure, or, in an assembly operation, the ram continues downward until the lower stroke-limit is reached, at which point the ram automatically reverses. The adjustment for maximum pressure can be reached easily through an access door in the rear panel. Stroke adjustments for both upper and lower positions are made from set collars located between the ram guides in the throat of the press.



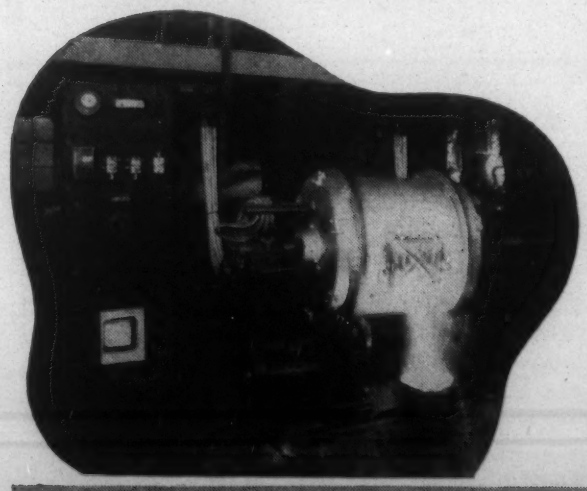
FERROUS OR NON-FERROUS - LARGE HEATS OR SMALL

Two characteristics set the DETROIT Rocking Electric Furnace apart from other methods of melting, (1) versatility, (2) flexibility.

DETROIT Electric Furnaces are used for melting virtually all commercial alloys of both ferrous and non-ferrous metals. Because of the rapid melting speed, inherently low metal losses (absence of oxidation) and accurate control over time and temperature, each heat can be perfectly controlled as to analysis and metallurgical results. Any size charge of any desired composition may be run; the operation may be any desired number of hours per day — continuous or intermittent.

The DETROIT Electric Furnace insures a homogeneous melt when either cold melting or duplexing. Special mixes for particular requirements may be produced as required at low cost.

A DETROIT Electric Furnace will afford a remarkable improvement in your foundry facilities. It will enhance and broaden your field of operations and add to your profits. Write for facts.



QUICK FACTS ABOUT DETROIT ROCKING ELECTRIC FURNACES

- For melting ferrous or non-ferrous metals and alloys.
- Built in eleven sizes from 35 to 7000 lbs. capacity.
- For cold melting or duplexing — continuous or batch type.
- Completely automatic melting cycle except for charging and pouring.
- Accurate metallurgical results of highest quality.
- Easy to install, simple to operate.

ROCKING ELECTRIC FURNACE
DETROIT
DIVISION OF KUHLMAN ELECTRIC CO., BAY CITY, MICH.
AGENTS IN 40 CITIES

Meco Cutmaster

The new "Meco Cutmaster Cutting Torch", manufactured by Modern Engineering Co., 3412 Pine Blvd., St. Louis, is of 3-tube construction with tubes of Monel metal for maximum heat resistance as well as structural strength. All other parts are of forged and extruded metals.

A patented head mixer is claimed to provide a perfect mix of preheating gases and allows for easy cleaning to eliminate overheating. The connection of tip to head is also of patented construction and eliminates leakage dangers both between high pressure passageways into the preheating passage as well as open leaks that endanger the operator. Much longer tip life is claimed as a result of these two patented features which protect the tip from overheating.

The high pressure oxygen valve is controlled by a long lever, mounted on top, and, because of the leverage the pressure required to operate the valve is claimed negligible. A thumb-operated locking device is conveniently placed at the end of the control lever. An additional factor to minimize fatigue in prolonged operation is the perfect balance built into the Cutmaster Torch.

The needle valves are equipped with Meco patented tension springs. These provide for automatic take-up against wear and assure accuracy of adjustment even if the torch is accidently dropped. All other moving parts, as well as the threaded connections and seats at the tip, are designed to permit adjustment to take up for normal wear without replacement. This assures extended torch life with low maintenance cost.

Magnetic Clutch and Clutch-Brake

A new Style "F" magnetic clutch and Style "FF" magnetic clutch-brake combination is announced by the Stearns Magnetic Mfg. Co., Milwaukee. These new magnetic clutches have been designed to meet the requirements of a compact, readily accessible clutch and clutch-brake combination, adaptable particularly for flywheel or through shaft application as found on power presses, power sheers, punch and stamping presses, die casting and similar operations.

A feature is the fact that they will fit into a surprisingly small area and their construction is much simpler than most magnetic clutches of similar ratings, and the speed of operation can be timed to meet exacting conditions. They can be supplied with the collector rings on the hub or on the body of the clutch or clutch-brake combination, whichever is desired.

The simplicity of design in these magnetic clutches and magnetic clutch-brake combinations affords ready accessibility for adjustments and lining replacement when necessary. They are made in a variety of combinations and sizes, information on which will be furnished by the Stearns engineering department. An added feature of the clutches is that they can be installed in the field to replace jaw or pin clutches or other types of mechanical drives, which can be replaced with magnetic devices.

Electrode Gives Smooth Welds

A new arc welding electrode, which is claimed to facilitate finishing operations on welded products by eliminating the need of dressing or smoothing welded seams in many applications, is announced by The Lincoln Electric Co., Cleveland. The new electrode, known as "Fleetweld 10", is designed particularly for finish bead welding on "U" groove welding in downhand position. The electrode provides full slag coverage and a weld deposit of exceptional smoothness, it is said. The bead is uniform and regular without square shoulders. The metal smooths out evenly during welding and the line of fusion with the base metal is practically unnoticeable. Finish beads can be made in V-butt joints in flat position which are flush with the surface of the plates. The surface of the bead made with the electrode has much less of the "rippled" effect which characterizes the usual weld deposit.

Fleetweld 10 can be used with either normal or reverse polarity with D.C. current, or with A.C. It is made in two sizes in 18-in. lengths, ¼-in. and $\frac{5}{16}$-in., and is packed in 50-lb. containers as standard packages.

Coatings for Magnesium Alloys

The development of new protective and decorative coatings for magnesium alloys has recently been announced by The Dow Chemical Co., Midland, Mich. According to Dow technicians two of these coatings, known as Treatment No. 7 and Treatment No. 8, surpass other known treatments in protecting magnesium alloys against salt water, and upon general atmospheric exposure are claimed to result in satisfactory adhesion surfaces for subsequent paint systems. Since they introduce no dimensional change, the new treatments may be used on parts machined to close tolerances.

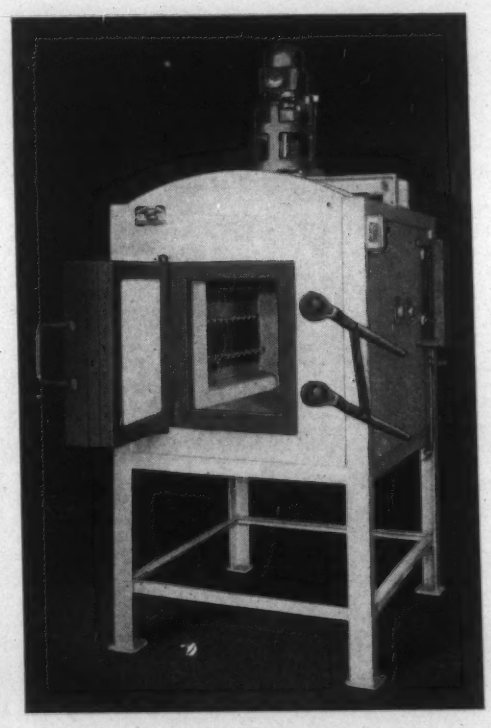
Treatment No. 7 is usually applied to Dowmetal parts after they have been machined. Dow research men claim that all surfaces, even deep holes, treat equally well. The treatment imparts a dark brown to black finish on most alloys, and may be used on all except Dowmetal M. It finds its greatest application in the aircraft field.

Treatment No. 8 may be used on all alloys and forms including Dowmetal M. It is said that this treatment does not affect machined dimensions and leaves machined surfaces with their original lustre. Complete treatment is obtained on all surfaces, including the bottoms of deep holes. Tidewater tests recently completed at Miami, Fla., show Treatment No. 8 to be superior to the chrome-pickle in protection against salt water corrosion.

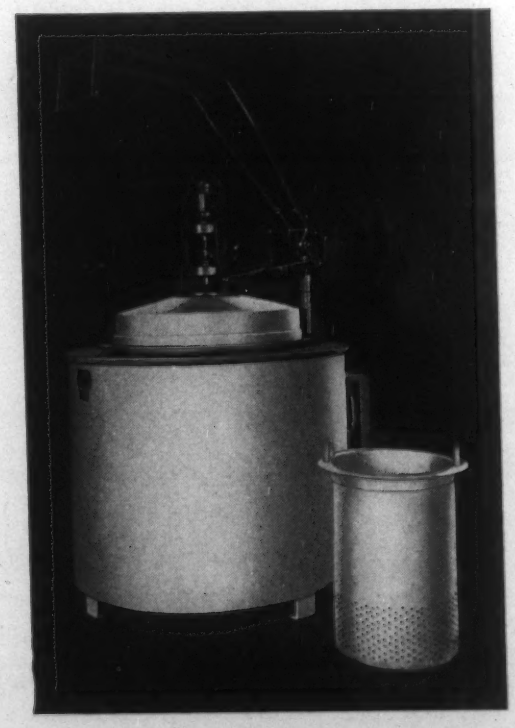
Another Dowmetal protective coating by means of which various colors can be produced, is known as Dow. No. 6. It is in reality a dye coating produced in water solutions at high temperatures and pressures. The coating can be furnished in colors ranging from yellow, red, blue, and green, to metallic lustres such as bronze and brass. Its greatest use is for decorative treatments. Some measure of success also has been attained in experimental electro-plating of Dowmetal, not yet in commercial use.

"AMERICAN" ELECTRIC AIR TEMPERING FURNACES

FOR LABORATORY AND PRODUCTION



Model NA furnaces illustrated below provide fast uniform tempering of production loads as well as laboratory and experimental work up to 1200° F. Powerful direct air circulation means fast dependable results at low cost. Cleanliness and simplicity of operation reduce labor charges.
Ten standard sizes from 6" diameter x 8" deep to 30" diameter x 48" deep.



Model AO-1 Furnace
Chamber 12" x 24" x 16"

The ideal unit for individual pieces or production loads up to 1200° F. May be fitted with rack or shelves for holding work.

Positive direct air circulation provides positive temperature uniformity.

Unexcelled for annealing and normalizing all aluminum alloys. Six standard sizes up to 24"x60"x24".

Model NA-21 Furnace
Container 16" Diam. x 20" Deep

If you want real results, buy "AMERICAN"

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All types Industrial Furnaces

Heat Resisting Compound

"Wonder Weld" heat resisting compound is a new, scientific, patented product, claimed capable of concentrating heat to any given spot in metal. This compound is expected to fill a long felt gap to welders, garage repairmen, auto body and fender shops and repair shops, when applying acetylene torch to any parts of cars for repair near glass, rubber, wood, upholstery, paint, etc., and is said to save time and labor of disassembling. It is harmless to fabric or skin and has unusual heat resisting qualities. The most common elements known and used today are effective to a limited degree only, and when exposed to direct flare, 800 or 900 deg. F. will disintegrate them to uselessness. They absorb as well as retain heat, therefore, protection is adequate only to a limited degree in so far as higher temperature developed by high temperature torches or welding mediums of today are concerned. Wonder Weld heat resisting compound has successfully withstood direct heat to which it has been subjected up to 7,000 deg. F., it is reported, says Miller Mfg. Co., Camden, N. J.

Only a few of the general uses for this compound are listed here. It is claimed it can be used to localize heat radiation as in welding, to protect painted or enameled surfaces from flare damage, to protect thin metal from buckling, to protect low temperature alloys, such as solder, etc., to prevent the dissipation of hardness away from high-tempered metals or as a protection when welding near rubber, glass, wood paints, upholstery, nickel, chrome and various other finishes.

It is said to be simple to use, is not gaseous and is harmless. Mix with clean water to a paste, spread over material to be protected about ½ or ¾ in. and apply heat to part to be repaired. Spread enough so as to prevent flare over-riding paste. Heat will remain in concentrated spot and will not radiate to other parts of metal, thus protecting finishes, glass, etc., and leaving parent finish as fresh as before heat was applied.

High Speed Hydraulic Press

The metal working industry will find many points of interest in the high speed hydraulic press built by the Charles F. Elmes Engineering Works, Chicago. It is said to be one of the fastest hydraulic drawing and forming presses in present day operation. Many engineering refinements and advancements are claimed incorporated in its construction: The new control features are extremely sensitive and accurate. The stroke adjustment of the moving platen, which is guided precisely on 4 adjustable gibs, is a very simple operation. The platen can be lowered a fraction of an inch at a time, facilitating the setting of dies. Moreover, the moving platen stroke is adjustable so that the idle stroke can be brought to a minimum resulting in an increase in operation.

The bed is arranged for a cushioned cylinder. All moving parts are pressure lubricated. The top head serves as an oil reservoir as well as the base for mounting the pumps, motor and controls. Ventilation is provided by louvres located in the cover. The press is of the housing type, all control equipment being fully enclosed, and is a complete self-contained unit including motor starter. Openings are provided in the two side housings into which are inserted illuminating lamps. These lamps are so arranged that the light is cast directly on the dies making the work easily visible to the operator. The press is exceptionally rigid in construction.

Welding Point Dressers

Air-operated hand-dressers with which welding electrodes may be dressed without removal from spot welders have been introduced by the Progressive Welder Co., Detroit. The dressers are available in two types: A "flat-plate" and a "shank" type. The former is designed for use where there is restricted space between electrodes but, like the shank type, may be used for all other welding electrode applications.

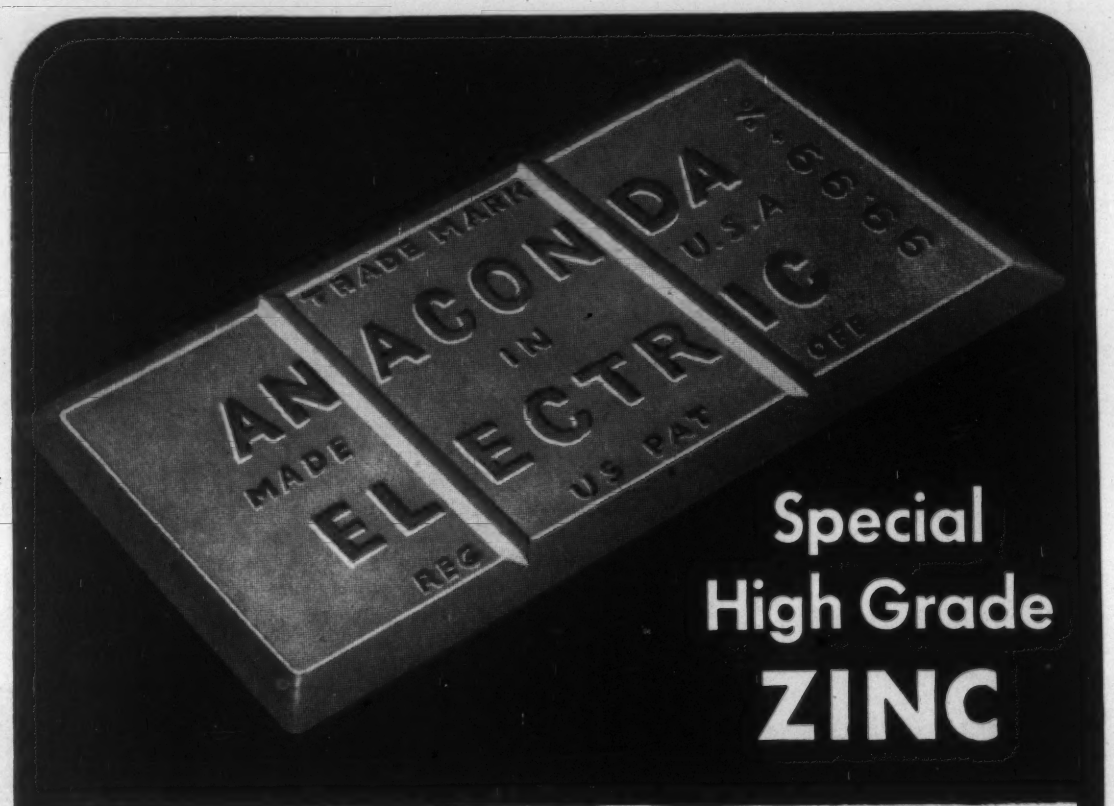
Designed to cut loss of time due to usual removal of the welding points for re-shaping, or eliminate inaccuracies of hand filing of mushroomed points, the dressers are claimed to be so simple to operate that they may be used directly by the welding operator with perfect results.

The dressers are designed for use of interchangeable blades to take care of varying electrode dressing requirements in the same shop, including dome shaped, long and short taper crowned points, and for various point sizes. Special cutters for specially shaped electrodes are available on special order.

In operation, the dressing of points is said to require only a few seconds. The cutter is merely held against the tip, a trigger on the dresser is pressed, and released as soon as the free running of the dresser tells the operator that the point has been completely re-shaped. The design is such that it is virtually impossible to remove too much metal with the dresser. It always restores correct radius. The "Presto" dressers are operated by attaching directly to regulation shop compressed air lines. Sturdy in construction, and built for long service, they are yet light in weight.

"Cadalyte" Bright Dip

The electroplating division of E. I. du Pont de Nemours & Co., Wilmington, Del., has issued a technical service manual giving data on the preparation and use of "Cadalyte" bright dip in cadmium plating. The bulletin describes what "Cadalyte" bright dip does, the procedure for its use, the preparation of the solution, the operation and the advantages claimed for it. It is stated that cadmium may now be deposited in a brilliant form directly from "Cadalyte" 39 plating solutions, consequently it is seldom necessary to use a "bright dip" for brightening purposes alone, as is common practice in many other electroplating processes. There are, however, it is stated, other properties of the deposits pertinent to cadmium that can be improved by subsequent treatment which make the use of a "bright dip" advantageous in many cases.



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Guaranteed 99.99+% Pure

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Anaconda Electric Zinc is supplied in 50 lb. slabs clearly marked "Anaconda Electric 99.99+%." Whenever you use this well-known brand, whether in small quantities or carload lots, you may be sure that *every slab will test 99.99+% pure.*

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1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

EDWIN F. CONE, SECTION EDITOR

2a. Ferrous

Dependence of Temperature—Viscosity Relations of Acid Blast-Furnace Slags on the Chemical Composition (Ueber die Abhängigkeit der Temperatur—Zähigkeits-Beziehungen saurer Hochofenschlacken von der chemischen Zusammensetzung) K. ENDELL & R. KLEY. *Stahl u. Eisen*, Vol. 59, June 8, 1939, pp. 677-685. Original research. The viscosity of 7 acid blast furnace slags was determined in a Hänlein viscosimeter. In this the slags are heated in an 80 Pt-20 hr. alloy crucible, a similar alloy sphere being suspended by a wire in the slag; the sphere is drawn up through the slag and the frictional resistance measured with a balance. The $CaO : SiO_2$ ratio of the slags was between 0.39 and 0.86 and the viscosity at 1400° C. was from 83 to 11 C. G. S. units (poises). A viscosity of 75 C. G. S. at 1400° C. indicated good runability from the blast furnace, the slags becoming still more fluid at higher temperatures. In the quaternary system SiO_2-Al_2O_3-CaO-MgO with $CaO : SiO_2$ ratios of 0.91 to 0.68, between 1350 and 1500° C., the melts became more fluid on small additions of K_2O, Na_2O, CaO, MgO, FeO arranged in increasing order of the effect. The same slags became more viscous on additions of SiO_2 and more so on additions of Al_2O_3. The greater the ratio of the sum of CaO + MgO + FeO + MnO + alkalies to the sum of SiO_2 + Al_2O_3 in wt. %, the lower became the viscosities. SE (2a)

New Blast Furnace Gas Washer Highly Efficient. B. B. FROST (Arthur G. McKee & Co.) *Blast Furnace Steel Plant*, Vol. 27, June 1939, pp. 569-571. Describes installation at Donner plant, Republic Steel Corp., Buffalo, N. Y. Existing primary tower washers were remodeled into single-stage, McKee-type washers, and wet-tube Cottrell precipitators for final cleaning were superimposed on these primary washers. This solved the problem of lack of space and resulted in considerable savings in installation cost as compared with conventional installation. Actual average gas flow through the units has been 125,000 ft.^{3}/min. Average of 13 tests with furnaces operating smoothly showed a dust content of 0.0064 gr./ft.^{3} Cleaning of washer can be fitted in with scheduled shut-downs for other work on furnace. Tests have shown that when furnace operation or conditions produce a high top temperature, it is much more difficult to clean the gas. MS (2a)

Decarburization of Granulated Pig Iron: The "R.K." Process. BO KALLING & IVAR RENNERFELT. *J. Iron Steel Inst.*, Advance Copy No. 7, Sept. 1939, 24 pp. Practical. The temperatures and compositions of gases necessary for the gaseous decarburization of pig Fe are discussed. Gaseous decarburization is more advantageous than decarburization with Fe ore because higher temperatures can be used without producing sintering. Times required for decarburization are estimated from diffusion constants. The process described is used at several Swedish plants for production of low-C Fe for manufacture of high-quality steel. The pig Fe to be treated is granulated in water. For decarburization it is passed through a rotary furnace and the required atmosphere maintained. As the decarburization is exothermic, very little extraneous heat need be added. The composition of the gas mixture in the furnace is regulated by burning the reaction gases leaving the furnace together with some blast-furnace gas, which is blown in a special way towards the inclined surface of the revolving charge. JLG (2a)

Steeprock Lake Iron Ore. O. W. ELLIS (Ontario Res. Foundation) *Can. Chem. Proc. Inds.*, Vol. 23, July 1939, pp. 353-354. Steeprock Lake is in the Atikokan area of the District of Rainy River. The ore is readily reduced to sponge iron in the presence of charcoal. The removal of the water of combination from the limonite present in the float ore results in the formation of a porous material, which is rapidly attacked by the reducing gases in low-temperature reduction at temperatures as low as 800° C. No fusion of the gangue occurred in any of the tests. The sponge iron prepared contained 93.3% Fe and 3.9% silica. It is doubtful whether high-grade iron can ever be produced and marketed in competition with pig iron made from the same ore. WHB (2a)

2b. Non-Ferrous

The Production of Aluminum (La Fabrication de l'Aluminium) A. CLERGEOT. *Electricité*, Vol. 23, Jan. 1939, pp. 1-4; Feb. 1939, pp. 49-53. General review. The first installment describes the different processes (in the U. S. and abroad) to produce pure alumina, the raw materials used, and the anodes. The second installment gives details about the production of Al from alumina and includes photographs and drawings of old and modern furnaces. The advantages of the Söderberg electrodes are discussed, as is the higher efficiency of big units and of furnaces with roof. A furnace with 22,000 amps. uses 20,000 kw.-hr. per metric ton and 600 kg. electrodes, as compared with 27,000 kw.-hr. and 800 kg. in an 8,000 amps. furnace. Automatic feeding has been abandoned. A table shows the advantages of electrothermic aluminum over electrolytic aluminum. The application of standard electric arc furnaces (calcium carbide type) and the advantage of a.c. is stressed. Finally, the refining furnace of the "Compagnie Alais, Froges et Camargue" is described. The bath consists of 23% AlF_3, 17% NaF and 60% $BaCl_2$. A drawing shows C blocks in the bottom, magnesite bricks in the walls, and a graphite electrode. Refractory bricks (type not given) are between walls and shell and below the C blocks. The shell is brazed. It operates with 10,000 amps., 7 v., a current density of 40 amps./cm.^{2}, at 750° C. The metal is claimed to be 99.99%-99.995% Al. JMN (2b)

Electrolytic Separation of Compound Materials. The separation and recovery of the individual components of metal combinations such as electroplated, clad and similar products is always an interesting problem, whether the purpose is to reclaim purchased scrap, to salvage the basis or plated metal from spoiled production, or to use the scrap as anode in electroplating. Sometimes such reclamation operations assume great economic importance, as, for example, in the case of detinning. Electrolytic methods, in which the compound material is made the anode in a suitable electrolyte, are only seldom applicable, because of the practical difficulty in removing the coating anodically without taking off too much of the basis metal. With Cu-plated Al, however, such practice seems to be entirely feasible, and Baisch ("Die electrolytische Trennung von Verbundwerkstoffen in ammoniakalischen Electrolyt," *Metall u. Erz*, Vol. 36, No. 8, 1939, pp. 216-219) describes a method of de-plating Cu from Cu-plated Al, using an acid electrolyte and a current density of 150 amps./in.^{2} Power consumed is 0.5 kw.-hr./kg.Cu. The Al is protected from attack by the formation of an oxide coating after the Cu is removed. Similarly, but with an ammoniacal electrolyte, Cu can be removed from Fe-base metals and 99.99% pure Cu produced directly on steel sheet cathodes, from which the Cu can be stripped periodically. The cathode current density is 100 amps./m.^{2}, and power consumption is 0.85-0.90 kw.-hr./kg.Cu. Recovery is accomplished in 48 hrs. When Zn is present in the plated metal, it can exist in solution up to 30 g./l.—above this it must be removed as a carbonate and filtered or centrifuged out.

In a subsequent issue of the same magazine ("Die elektrolytische Trennung von Kupfer- und Messingplattiertem Eisenschrott im Zyanidbad," *Metall u. Erz*, Vol. 36, No. 9, 1939, pp. 240-244) C. SCHAARWÄCHTER describes the application of another type of alkaline bath (cyanide) to the electrolytic separation of copper-plated or brass-plated iron scrap. The scrap is placed in anode coffers and treated with a 10% NaCN solution, forming Na-Cu cyanide (electrolytically dissociated to Cu and NaCN), H_2, and NaOH. The last is important as it increases the solubility of the Cu and protects the cyanide from the CO_2 in the atmosphere. An e.m.f. less than 1.5 v. is used to prevent loss of cyanide through oxidation to cyanate, and the voltage rises during the electrolysis. With the voltage maintained at not over 0.9 v., at the end (4 to 5 days) the current is about a tenth that of the beginning. Total power consumed is about 1.0 kw.-hr./kg.Cu. A Cu-Zn alloy (Tombak) can also be produced having the same composition as the originally removed plate. Analyses of the unmelted cathodes are 99.98% Cu and 0.005% Fe for the Cu, and 90.20% Cu, 0.009% Fe, 9.78% Zn and 0.01% Mn for the Tombak. A description of the plant is given. PCR (2b)

3 Melting, Refining and Casting

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5

C. H. HERTY, and G. L. CRAIG,

SECTION EDITORS

Control of the Solidification of Castings by Calculation. N. CHVORINOV. *Foundry Trade J.*, Vol. 61, Aug. 10, 1939, pp. 95-98. Review plus research. In solidification, the feeding is chiefly responsible for the soundness of a cast metal. Character of crystallization, capillarity, fluidity of liquid metal, gas evolution, etc., all play some part in the process of feeding and affect the resulting soundness. No quantitative laws have so far been defined to cover the phenomena of primary crystallization of metals. The size, form and number of crystals are governed not only by the rate of cooling but also by the temperature gradient, by preferential crystallization along crystallographic axes, by chemical composition, by purity of metal and even by gravity. For the sake of illustrating the actual conditions of solidification of castings, some experimental results are given. The temperatures of a sand-cast plate (steel) during solidification are given for different time intervals after casting and for various distances starting from the surface. It is shown that the surface temperature remains approximately constant during the whole period of solidification. The temperature gradient dT/dx at the mold-metal interface for any time during the solidification period gives the rate of heat loss, which is in perfect accord with the parabolic law of heat diffusion. The mathematical solution of the progress of solidification of a semi-infinite mass of metal is given by the formula $x = M\sqrt{t}$ where x represents the thickness of solidified metal, t the time after casting and M is the solidification constant that must be found from an equation of solidification. The general formula for the solidification period t is given by $t = R^2/M^2$ where R is the given ratio of volume to surface area of a casting of finite dimensions. For steels of the usual chemical compositions (plain carbon and alloy steels) and average pouring temperature cast in dried molds at room temperature, the value of M was calculated by the author to be 2.09 in. if R is expressed in inches. Application in intricate castings, application to cores, heat-diffusivity constants, etc., are also discussed. AIK (3)

3a. Ferrous

The Influence of Some Special Additions on Certain Properties of Cast Iron. P. G. BASTIEN & L. GUILLET. *Iron Steel Inst., Carnegie Schol. Mem.*, Vol. 27, 1938, pp. 77-143. Research. The effects of Co, Ti, B and Ce on the rate of graphitization and on the mechanical properties of cast iron were studied. Cobalt and Ti are "graphitizers" while B and Ce are "whiteners." Cobalt increases the corrosion resistance slightly, but lowers the mechanical properties of cast iron; Ti has a more complex effect on the mechanical properties due to the graphitizing action and the ability of Ti to refine the structure of the graphite. Small specimens were subject to partial martensitic hardening due to the high Mn content (1.08%). The corrosion resistance drops with Ti up to about 0.40%; beyond this percentage corrosion resistance rises again. The hardness drops to a minimum (graphitizing influence) and then rises with Ti additions. The modulus of elasticity and shear strength behave similarly. Boron raises the mechanical strength of gray cast irons, but lowers their capacity for deformation (more deflection at rupture in static transverse test). The hardness, modulus of elasticity, shear and bending strength were increased regularly with the B percentage—as would be expected from the tendency of B to form white iron. The ductility consequently is decreased.

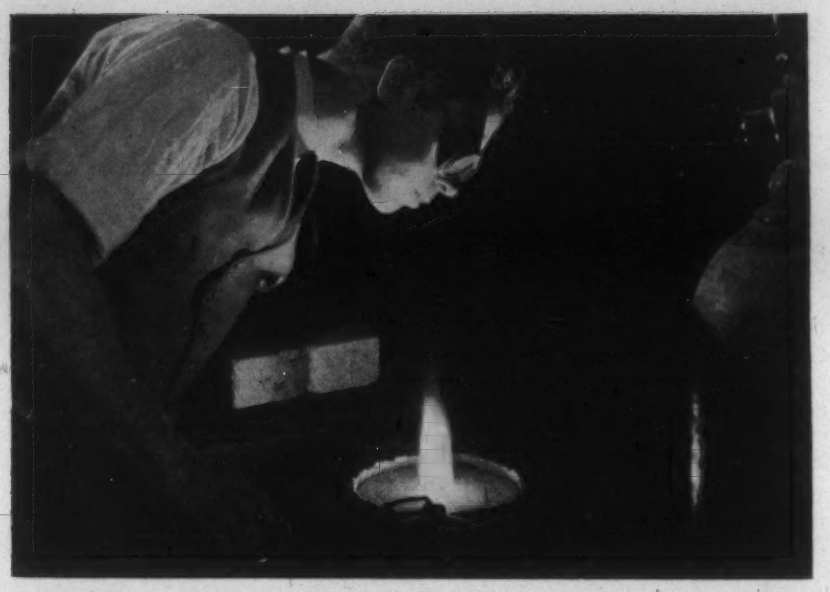
Cobalt promotes graphitization during solidification and also during annealing by lowering the temperature of incipient graphitization during annealing. The presence of Ti carbide in high-Ti alloys was detected under the microscope. The limit of solubility of Ti is less than 0.03%. In the casting with highest C and Ti contents both Ti carbide and Ti nitride were found, the latter in smaller quantities. Boron opposes graphitization both during solidification and during annealing. The "whitening" effect of B begins only at a content of 0.1% B. B raises regularly the A_0 temperature, which confirms the existence of a complex cementite Fe_3C-Fe_2B. B retards the decomposition of cementite but does not seem to influence the temperature at which graphitization begins. At 0.2% (added in an induction furnace) it also retards the decomposition of cementite on annealing. In practice this may be important for the production of black-heart malleable iron.

The influence of the above added elements on chilling properties, microstructure, graphitization (and growth due to annealing), Curie point of the cementite, resistance to corrosion in dilute nitric acid, and mechanical properties was studied. The mechanical properties observed were hardness, Young's modulus, shear strength and deflection (static transverse test). CW + RPS (3a)

Primary Crystallization of Steel; Undercoolability and Germination in Liquid State (Zur Frage der Primärkristalisation des Stahles; Unterkühlbarkeit und Keimbildung im flüssigen Zustand) P. BARDENHEUER & R. BLECKMANN. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch. Düsseldorf*, Vol. 21, No. 13, 1939, pp. 201-212. Experimental. The crystallization velocity and germ number, stated to be determining factors for the structure and mechanical properties of a steel, were investigated as function of undercooling through the making of temperature-time curves. For cooling velocities of about 40° C./min. and under given conditions undercooling of 250° C. can be obtained, with a consequently high crystallization velocity. If the melt is less undercooled a definite time is observed to elapse before spontaneous crystallization starts. With increasing C content, up to 1.38% in the tests, the obtainable undercooling seems to decrease, but the conditions of crucible and melt (roughness of walls, cooling and movement of melt) considerably influence the magnitude of undercooling and spontaneous crystallization. Overheating of the steel melt of about 20° C. over the liquidus line produces subsequently full undercooling, which is not changed by higher overheating or longer holding of the melt at the temperature. Additions of Al, Be, B, Ca-Al, Ca-Si-Al, Ti, V and Zr suppress undercooling entirely, but N, Mn, Si, Ca-Si, Cr, Co, Mo, Ni, Cb + Ta, P, S and W, and C together with Si, Cr, W and W + Cr do not prevent undercooling. Hydrogen and iron oxide reduce it strongly but do not suppress it entirely. 17 references. Ha (3a)

The Effect of Casting Temperature on the Primary Microstructure of Cast Irons. A. L. NORBURY (British Cast Iron Res. Assoc.) *J. Iron Steel Inst.*, Advance Copy No. 8, Sept. 1939, 15 pp. Theory and research. Treatments of the melt that coarsen or refine the graphite eutectic structure in gray iron were found to have no corresponding effects in white iron. Differences in casting temperatures, however, produced remarkable differences in primary microstructure. In hypereutectic white iron compositions, lower casting temperatures greatly reduced the size of the primary carbide plates. In hypoeutectic white iron compositions, lower temperatures refined the dendritic structure of the primary austenite, so that it was replaced by a globular austenite structure. The microstructures are interpreted as showing that the primary dendrites result from the joining of globules, and that large primary plates result from the joining of smaller plates.

Lower casting temperature refined the dendritic structure of ordinary gray iron compositions in a similar manner. In 14% Si-Fe (δ Fe) there was not a comparable refining effect. This difference is attributed to the recrystallization of γ Fe on solidification, due to the occurrence of the $\delta \rightarrow \gamma$ allotropic change and to the non-recrystallization of δ Fe, both being assumed to be in the δ Fe allotropic condition in the liquid state [*sic*]. In the same way it is suggested that pure C is in the diamond allotropic form in the liquid state, and solidifies without allotropic change when diamond is formed but with allotropic change when graphite is formed. In cast iron compositions, C is assumed to be in diamond form in the liquid state and to form a diamond-Fe compound (Fe carbide) when it solidifies without allotropic change, but to form graphite, as above, when it solidifies with allotropic change. JLG (3a)



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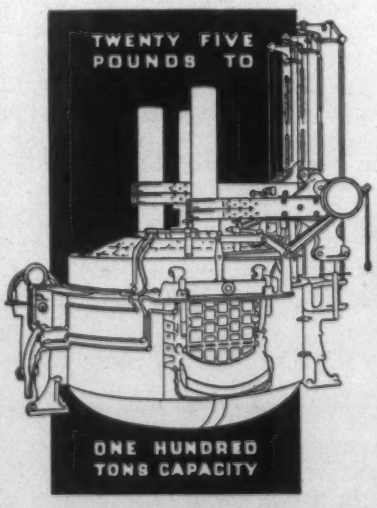

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Avoidance of Manganese Losses in the Open-hearth Process (Vermeidung von Manganverlusten bein Siemens-Martin-Verfahren) P. BARDENHEUER & G. HENKE. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch. Düsseldorf,* Vol. 21, No. 16, 1939, pp. 243-260. Research. Recent experience has proved that it is possible to keep the O content of a steel melt low by vigorous C reaction and yet to utilize the Mn in the melt so that the finished steel is not only low in O but contains, even with comparatively small Mn addition, enough Mn so that no subsequent addition of ferromanganese is required. Experiments were made to find the relation between melting practice and Mn yield, in the duplex process. A yield of 60% of the Mn in a steel of good quality is obtainable; this requires a melt with a sufficiently high original C content in order to keep the FeO content low by long and vigorous boiling. A highly basic slag, which is usually present in the ordinary process, could be obviated in the new process, the line requirement being reduced from about 10% to 4.2%, with simultaneous decrease in the total amount of slag. In this manner, a mild steel of 0.5% Mn content was obtained from a total original supply of 0.8-1% Mn, without ferromanganese addition. In order to reduce the C and Mn losses (by contact with air) during tapping (which amounted to 27% for a 100-ton melt) a new tapping method was employed. The ladle was at first held practically horizontal to the tap hole and then gradually tilted as the ladle filled up, so that the free-flowing metal jet was kept very short and, particularly, all eddying of the jet in the ladle was avoided; this cut down the Mn losses to about ¼ to ⅓ of the former amount, and 50% ferromanganese could be saved. Ha (3a)

3b. Non-Ferrous

Permanent Mold Castings. Among recent articles on permanent mold castings (or gravity die castings, if you will) have been descriptions of German practice in handling Cu alloys and of British methods as applied to Al alloys.

KALPERS ("Erfolge beim Kokillenguss von Kupferlegierungen," *Tech Blätter,* Vol. 29, Aug. 27, 1939, pp. 447-448) describes a number of methods for gravity die casting heavy non-ferrous metals of intricate shape and relatively thin wall thickness. In one method the die is heated to red heat, and small amounts of oil, talc or the like are inserted before casting, and the die covered with a special facing material. In another method cold dies are used, but they are first heated, and then immersed in a water bath containing finely dispersed insulating materials, which are deposited on the die surface and form a thin, uniform insulating coating. Dies thus treated require no cleaning before use. Among die coating materials, colloidal graphite (Hydrokollag, German patent 511,101) has been advantageously applied.

A description of aluminum permanent mold casting practice at a British motor plant producing 35,000 castings (30 tons) per mo. is given by J. J. MILLS ("Aluminum Gravity Die-Casting," *Metal Ind., London,* Vol. 54, June 23, 1939, pp. 655-658; July 7, 1939, pp. 11-13). Three open-flame furnaces and one ½-ton tilter are used for melting. A number of auxiliary furnaces are used, kept at temperature suitable for the particular die which they serve. Crucibles are used in preference to iron pots. At first the company standardized on an alloy containing 7% Cu and 3.5% Si, but because of excessive aging in service, a composition of 4% Si, 2% Cu and 2% Ni was finally adapted. Pinholing was reduced by eliminating both overheating and repeated melting in oxidizing atmosphere. The working temperature of the die is in the range 300°-400° C. The dies are built up in sections to avoid distortion. Castings are put in frames for cooling to eliminate twisting. The construction of a gear box die is described, with details on die, core and materials used. A common die iron contains 3.2% C, 1.8% Si, 1.0% Mn, 0.06% S, 0.25% P and 0.2% Cr, but under ordinary conditions properly coated mild steel gives excellent service. GN + RWB (3b)

The Evolution of the Founding of Aluminum and the Light Alloys (L'Evolution de la Fonderie de l'Aluminium et des Alliages Legers) R. GUILLEMOT. *Tech. Moderne,* Vol. 31, May 1, 1939, pp. 323-326; May 15, 1939, pp. 368-371. Review. Factors to be considered are: (1) Al absorbs large amounts of reducing gases; (2) the volume change from casting temperature to room temperature is large (contraction about 6.3% for Al); (3) casting properties are only fair (spiral tests are about equal to those of brass); (4) hot strength is not great. Castability is increased by 4 and 10% Cu, 10% Si, 10% Zn, and 8% Mn. The Al-Cu alloys (3-12% Cu, average 8%) are widely used. The castability of the 8% Cu alloy is increased by 2.5% Si. Si or Mg are common additions to this type. Al-Si alloys, especially with 13% Si, are popular. With over 20% Si the alloy has a very low coefficient of expansion and is used for pistons of Diesel engines. Al-Mg alloys

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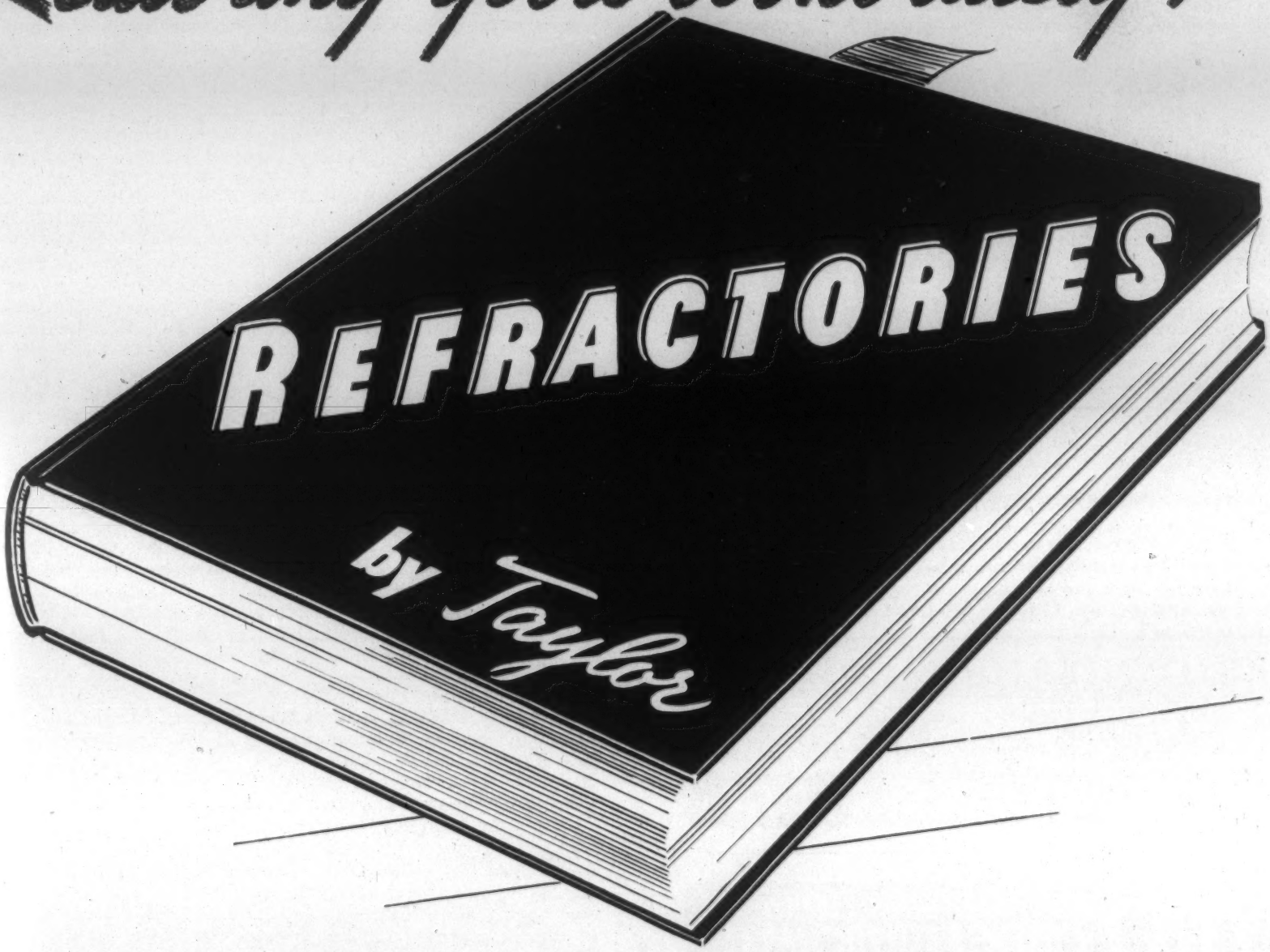

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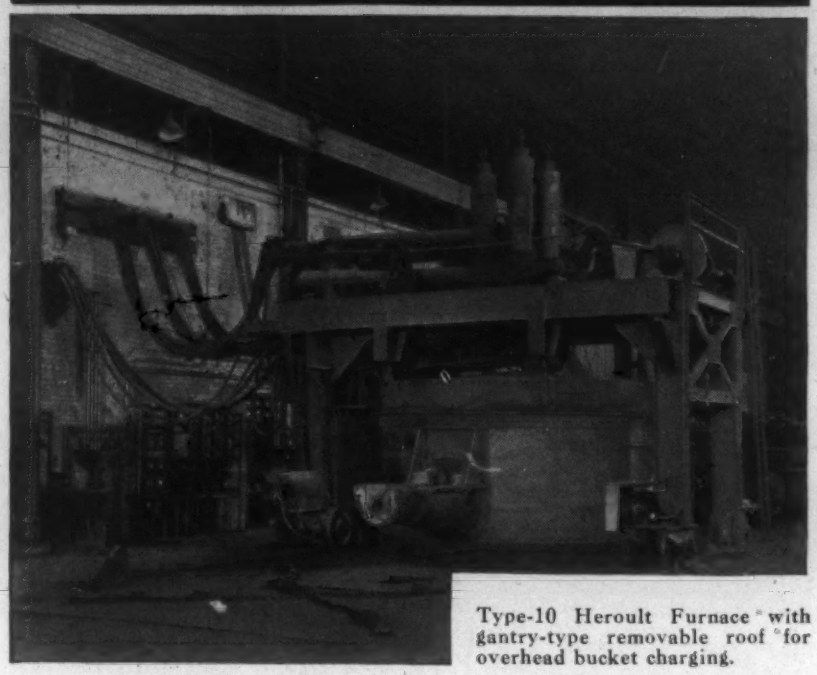

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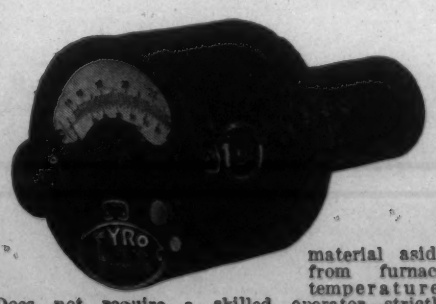

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with 7-12% Mg have good corrosion resistance, but it is difficult to avoid oxidation in the furnace. Ca improves the oxidation tendencies but increases the length of the heat treatment. 0.02% Be decreases the oxidation, but causes grain growth and has a deleterious effect on the mechanical properties. Therefore an addition of 0.02% Ti is made to refine the grain. The KS type with Mn and Mg is extensively used in automobiles and aircraft. Because of the possibility of dampness, ordinary sand molds are generally to be avoided, and sand with artificial binders (linseed oil, dextrine, etc.) should be used. Die castings were first made of the Zn alloys, but these were then replaced by the 12% Si alloy and that with 5% Si + 4% Cu, both of which gave superior properties. Die design, cleaning, properties, and applications of the Al alloys are discussed briefly. JZB (3b)

The Use of Carbonyl Nickel Powder in German Melting Shops (Ueber die Verarbeitung von Carbonylnickelpulver in Einschmelzbetrieben der deutschen Metallindustrie) P. ASSMANN & L. SCHLECHT. *Metallwirtschaft,* Vol. 18, June 2, 1939, pp. 467-468. Practical review. Nickel powder is being produced in Germany by a carbonyl high-pressure process (DRP. 618,108) from Canadian Ni-bearing ores. Pure Ni is prepared for industrial uses by melting the Ni powder in coke-fired crucibles or in coreless induction furnaces. In the latter case approximately 25% solid scrap must be added to the Ni powder to speed up the melting process. A protective covering of sand or glass is used, additional Ni powder being added by stirring it in under the liquid slag. For deoxidation or desulphurization alloys of Ni with Mg or Mn are used. By heating the Ni powder at 1000° to 1200° C. sintered blocks for forging or rolling can be produced. Nickel-chromium alloys are made in the induction furnace, scrap from a previous charge being used to start the melting operation. After sufficient Ni has been introduced the slag covering is removed and pre-warmed Cr added. Nickel-copper alloys are easily made by adding the Ni powder gradually to Cu. The powder alloys readily with Al and is used for alloying purposes by wrapping the powder in Al foil and adding it in this fashion to the melt. GA (3b)

Experience in the Manufacture of Zinc Alloy Castings (Erfahrungen bei der Verarbeitung von Zinkformgusslegierungen) L. SCHUSTER. *Metallwirtschaft,* Vol. 18, June 23, 1939, pp. 547-548. Practical. Describes the results of 3 yrs. experience with zinc alloy sand castings. The sand is worked up in much the same way as for brass founding. Brass mold design does not have to be changed for zinc casting alloys as these alloys are satisfactory for complicated thin-walled parts. Because of the higher shrinkage of zinc alloys more risers have to be used than for brass castings. The zinc casting alloy containing 4% Al and 1.2% Cu can be melted in iron or graphite crucibles whereas the casting alloy containing 0.2% Al and 4% Cu, because of the danger of iron pick-up, has to be melted in graphite crucibles. Overheating is to be avoided as it results in an embrittling action. The high-Al alloy should not be heated over 480° C. and is poured at 410° to 460° C. while the high-Cu alloy should not be heated over 600° C., and is poured at 550° to 580° C. The Zn-Cu alloy is superior in that castings are sounder and are not so sensitive to Pb and Sn impurities as the Zn-Al alloy. It has been ascertained that Zn castings do not represent an increase in cost over brass castings. GA (3b)

Influence of Magnesium and Impurities on the Engineering Properties of Zinc-base Zinc-Aluminum-Copper Die Castings (Einfluss des Magnesiums und der Verunreinigungen auf die technischen Eigenschaften des Zinkspritzgusses auf Zn-Al-Cu-Basis) EDMUND R. THEWS. *Chem-Ztg.,* Vol. 63, July 12, 1939, pp. 480-482. Practical. Small Mg additions are made to the otherwise "pure" alloy especially if the casting is to be removed from the die shortly after solidification. If the alloy contains Cd, Pb and Sn as impurities its resistance against intercrystalline corrosion drops. Magnesium additions can compensate for this and increase the strength, but the castability is impaired. If this latter influence is critical (as for example with intricate shapes and thin-wall designs) Mg should not exceed 0.04%; for ordinary purposes 0.05 to sometimes 0.08% is used. Magnesium has to be added to the metal by means of a stirrer; after it has dissolved stirring is continued for a while, then the bath is allowed to rest for 2-3 min., and slag is removed. The mother alloy is prepared by dissolving Al in previously deoxidized molten Cu. This alloy is then added to the Zn.

Lead in amounts of less than 0.004% is not harmful to corrosion resistance. If the amount of Sn + Pb is 0.01% their influence can be eliminated by the addition of 0.03% Mg. The effect of Cd becomes noticeable above 0.004%. Tin alone should not exceed 0.005%. Iron is easily controlled because it combines with Al, rises to the surface and can be removed. Nickel, in amounts of 0.02 to 0.04%, increases the corrosion resistance and mechanical strength, but more than this may be detrimental. The small amount of Si introduced by Al is harmless. The casting temperature is 420°-450° C., the die temperature 100°-150° C. RPS (3b)

4 Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER

AND H. W. GRAHAM,

SECTION EDITORS

Tools for Deep Drawing and Pressing. Part I. J. D. JEVONS. *Metal Ind., London,* Vol. 55, July 7, 1939, pp. 3-6; July 21, 1939, pp. 59-62; Aug. 4, 1939, pp. 105-109. General review. The ideal tool should be of reasonable cost; easily shaped; highly resistant, during service, to plastic deformation, abrasion, scoring, fouling; and "slippery". As the material usually forms but a small part of the cost, it is usually economical to use the best available material. Ease of machining remains a factor in die material despite the improved cutting materials available. The ease of heat treatment is also an important factor, and one of the advantages of cast iron as a tool material is that often it can be used in the unquenched condition. A common cause of cracking in all types of tool steel is said to be marked residual "ingotism". In addition to structural defects, the presence of internal stresses residual from inadequate normalizing after forging constitutes a potential source of cracking.

Distortion is a defect equally effective in spoiling an expensive die or punch and is caused by residual stresses from forging, heat treating and the "natural tendency" of certain grades of steel to distort. The properties of plastic deformation, abrasion, scoring, and fouling often seem paramount to the exclusion of all others. The remedy for too-ready plastic deformation lies in the use of a tool material possessing a sufficiently high proportional limit. Macro-attrition, in the form of abrasion and scoring, is produced wholly by the action of foreign matter which finds its way between the tool and work. The resistance to this sort of abrasion increases with increasing hardness. Once the tool starts to foul the loading is cumulative. The most serious result of fouling is the time required to clean the loaded tools. The greatest difference in hardness between the tool and the sheet seems to be the best remedy for fouling. Less trouble with fouling is encountered when drawing brass than with steel. The tendency to foul evinced by any given sheet and tool is influenced by the load, the speed of drawing, the nature and efficiency of the lubrication as well as by the chemical composition of the two materials themselves.

"Slipperiness" is manifested by two sliding solids dependent on relative coefficient of friction. It lessens the resistance to flow of the sheet over the tool radius. The unique position occupied by hardness as a property of tools is due to the fact that it is the only one of many important properties which can be measured accurately and quickly. It is the conviction of the author that the benefits derivable from a really smooth and well polished surface on the working regions of deep drawing tools is insufficiently appreciated and that most of the arguments against the use of polished tools are unfounded. RWB (D-4)

Grinding Materials. Some interesting information on the use of diamond impregnated materials and boron carbide, as compared with conventional silicon carbide practice, is presented in two articles in German magazines.

The application of diamond-"hard metal" combinations for grinding purposes is discussed by W. DAWIHL & A. FEHSE ("Diamant-Hartmetall für Schleifzwecke", *Maschinenbau Betrieb*, Vol. 18, July 1939, pp. 349-350). The binder for diamond boart should be hard, in contrast to that used for silicon carbide grains, because the rate of interchange of grains in the case of diamond is to be much smaller. Hard metal (presumably tungsten carbide) has similar expansion properties as diamond, and wets the boart. If the tool is used for the removal of large quantities of material, coarse grain (0.15-1.0 mm.) is recommended; for finishing operations, finer grain (down to 0.06 mm.), and for high-polishing, grains smaller than 0.06 mm. should be used. Diamond grinding tools are cleaned with steel brushes. If they lose grip they are ground over with silicon carbide wheels of medium grade and sand blasted or etched to expose the boart. Applications for finishing sintered hard metal tools, for working glass, etc., are listed, and typical applications described.

Another method of grinding sintered carbide tools, employing boron carbide as the grinding material, is described by W. DAWIHL & E. WESENBERG ("Feinschleifen von Hartmetallwerkzeugen mittels Borkarbid", *Werkstattstechn.*, Vol. 33, Aug. 1, 1939, pp. 373-376). Though the grains of boron carbide are harder than those of silicon carbide, no practical bond has been found for their use in grinding-wheels. Grinding is done with cast iron wheels with the boron carbide applied on their surface mixed with oil as a paste. Pregrinding is always done with silicon carbide. If used for fine grinding, the speed of the boron carbide wheel has to be far lower than that of the silicon carbide wheel, and the grain size of the boron carbide particles should be 60-100μ. The time for fine grinding is the same as with silicon carbide, but the resulting surface is better than that obtained with silicon carbide, and almost equal to that obtained with diamond powder. Costs are about the same as with silicon carbide. RPS + JMN (G-4)

4a. Ferrous

Machining Practice and Machinability of Steels. Recent years have seen not only great advances in equipment and tools for machining and in our knowledge of machinability and therefore of good machining practice, but also in the machinability itself of steels in general. Coupled with the last has been the development of new steels of the free-machining grade and the improvement of standard free-machining (Bessemer) steels.

S. A. E. 1045, a steel generally considered to be of poor-machining quality, was selected by O. W. BOSTON & W. W. GILBERT ("An Analysis of Machinability Data from Cold-finished and and Heat-treated S. A. E. 1045 Steel", *Preprint, Am. Soc. Metals,* Oct. 1939, 20 pp.) as the "guinea pig" for a series of tests showing the relation of physical properties and microstructure to machinability of variously heat-treated 3-in. bars. The separate treatments comprised: Cold-finishing; oil-quenching from 1520° F., oil-quenching at 1520° F., tempering at 600° F.; oil-quenching at 1520° F., tempering at 800° F.; oil-quenching at 1520° F., tempering at 1000° F.; annealing at 1600° F. All tests were run dry, using 18/4/1 high speed steel tool under standardized rake and angle conditions.

If the cutting speed for a given tool life of the oil-quenched bar is represented as 100%, then that for the quenched and drawn at 600° F. bar is 111%; for the quenched and drawn at 1000° F., 124%; for the cold finished bar, 168%; and for the annealed bar, 180%. Corresponding values of tool life, in minutes, for a cutting speed of 130 ft./min. are 0.3 for the quenched bar; 0.8 for the quenched and drawn at 600° F.; 2 for the quenched and drawn at 1000° F.; 37 for the cold finished bar; and 64 for the annealed bar. The tangential turning forces are higher for the harder metals. More efficient cutting, from the standpoint of power per in.^{3} of metal removed, can be done by taking the heaviest possible cuts. When turning the bar quenched and drawn at 600° F. at various speeds, the quality of the machined surface is improved as the cutting speed is increased. The best surface quality is obtained at the highest speed.

The cutting speed for a specific tool life increases for each bar as the ultimate strength of the bar is reduced. The hardness and the tangential cutting force fall off as the ultimate strength is reduced. Cutting force cannot be used to predict tool life for quenched and drawn bars. When operating at cutting speeds that would give the same tool life for all bars, the quenched bars and the quenched and drawn bars have a better surface finish than the annealed.

This steel, however, and several others rated as poor-machining may be elevated to the free-machining classification by the addi-

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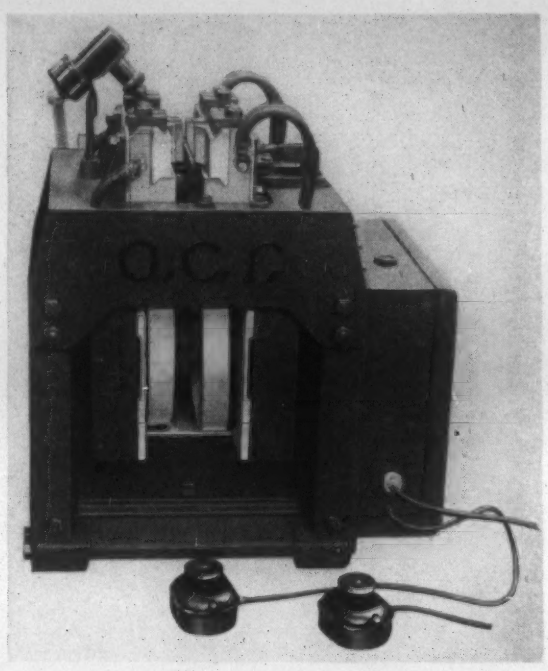

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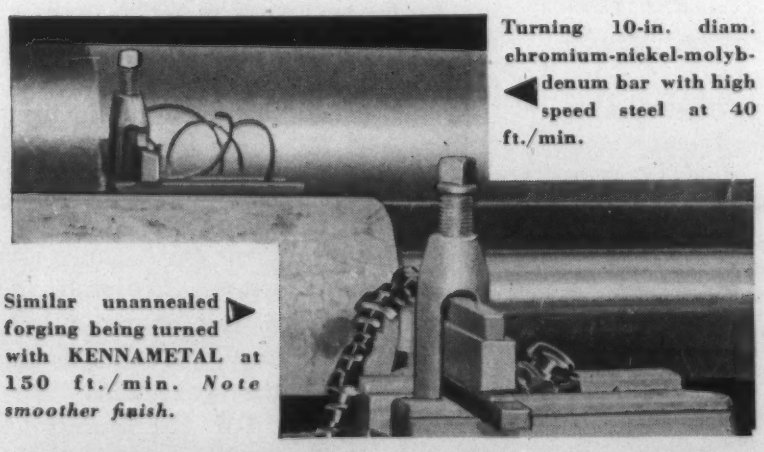

Turning 10-in. diam. chromium-nickel-molybdenum bar with high speed steel at 40 ft./min.

Similar unannealed forging being turned with KENNAMETAL at 150 ft./min. *Note smoother finish.*

Note the smoother finish of the steel forging machined with KENNAMETAL in the foreground of the illustration as compared to that of the same stock in the background being machined with high speed steel. Surfaces of the stock are unretouched.

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tion of suitable amounts of lead, according to tests of F. J. ROBBINS & G. R. CASKEY ("A Discussion of Leaded Steels", *Preprint, Am. Soc. Metals,* Oct. 1939, 29 pp.). The results of production machine tests are summarized in a "machine chart" in which the performance of each grade of lead-bearing steel is compared directly with the similar standard grade without lead. The paper extends work previously reported in *Iron Age* and *Metals and Alloys.* Among the non-leaded steels, only Bessemer screw stock S. A. E. X-1112 and S. A. E. 1112 can be classed as very free machining. Lead additions to these steels increase their machinabilities in about the same proportion as most of the other steels. For some steels (S. A. E. 1115 and 1120) the improvement through adding lead is disproportionally high, however, and gives these steels a ranking somewhat higher than non-leaded Bessemer screw stock and only slightly lower than the leaded Bessemer steels. Leaded Bessemer will be found under average conditions to be subject to the same shortcomings as the non-leaded type—lower strength, toughness and mechanical dependability than the open-hearth steels in general. Mechanical property tests indicate no deterioration of quality because of the lead addition to open-hearth steel, so that such leaded steels offer an exceptional combination of mechanical quality and machinability. On the other hand, lead-bearing steels are not the answer to all machining problems, nor can they be used for all types of parts, particularly where not enough machine work is performed on the part to justify the added cost for free-machining quality.

[The natural question is: Does all this mean that Bessemer screw stock's sun has set? The answer seems definitely to be "No". Not only do the Bessemer steels have definite advantages as to stiffness, weldability and work-hardenability that are highly attractive for certain applications, but recent improvements in production methods have greatly enhanced their already superlative machinability. According to a recently distributed report of the Jones & Laughlin Co., the new "Bessemer Flame Control" method of controlling the uniformity of the converter product has made it possible to provide the user with material of the maximum machinability; improvements in machinability over the average results with former screw stock are said to be as high as 50% in some cases. Thus, present comparisons of leaded open-hearth steels with non-leaded Bessemer screw stock may be due for some readjustment, and with claims of generally improved mechanical quality being expounded for the Bessemer steels, it looks as though Bessemer screw stock is certainly going to hold its own. Many people believe, too, that the field of the leaded open-hearth steels will expand not at the expense of Bessemer screw stock but at that of analogous non-leaded open-hearth steels.—F.P.P.] (G-4a)

4b. Non-Ferrous

Working and Mechanical Strength of Coarse-grained Clad Sheets of the Aluminum-copper-magnesium Type under Different Annealing Treatments (Verarbeitungs- und Festigkeitsfragen bei grobkörnigen plattierten Blechen der Gattung Al-Cu-Mg nach DIN 1713 bei verschiedenen Glühbehandlungen) C. H. SCHRÖTER. *Aluminium,* Vol. 21, Aug. 1939, pp. 589-591. Experimental. It had been observed that the surfaces of Al-Cu-Mg alloy sheets showed in places a very spotty and scarry appearance. Investigation into the causes disclosed that cold-working between 3 and 10% should be avoided if the normal heat treatment temperature of 495°-505° C. is to be used, for under such conditions a tendency for coarse-grain formation exists; this amount of cold reduction happens to be just about the range used in manufacturing operations. The critical cold-working degree shifts to lower values with increasing annealing temperature, *e.g.* on annealing at 460° C., coarse-grain was not developed unless cold-working had exceeded about 13%; at 500° C. this critical deformation amounts to only 4%. A material with this tendency to coarse-grain formation can be made suitable by deforming it, before the actual working process, beyond the critical degree (about 15-20%) and then recrystallizing it. The formation of coarse-grain considerably reduces physical and mechanical properties, and makes the sheets less suitable for deep-drawing. Ha (D-4b)

The Condition of the Material for the Extrusion of Pure Aluminum (Zur Frage des Verarbeitungszustandes beim Kaltspritzen von Reinaluminium) H. A. J. STELLJES. *Aluminium,* Vol. 21, Apr. 1939, pp. 297-300. The extrusion process of metals is discussed in general and the conditions for Al in particular are described. The extrusion process is considered to be a kneading process for which it is very important whether the material is soft or hard, fine- or coarse-grained. In order to use as little energy as possible, the material should be annealed, without, however, developing coarse grain; practical tests with pure Al have shown that a soft, fine-grained structure was best and gave the smoothest surface on the extruded parts. No coarse-grained material should be used. 8 references and 2 tables of extruded materials and their structure are given. Ha (D-4b)

5 Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering, Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.

O. E. HARDER and H. DREVER
SECTION EDITORS

A Chemical Method of Determining Temperature (Ein chemisches Verfahren zur Bestimmung von Temperaturen) PENZIG. *Chem. Fabrik,* Vol. 12, July 19, 1939, pp. 358-359. Descriptive. The difficult task of obtaining surface temperatures of moderately heated materials has been made considerably easier through the development of metallic salts which change color at a specific temperature. The salts are mixed with a binding agent and sprayed or brushed on the test piece. Pencils of the salts are now being developed. Twelve compounds have been prepared which produce irreversible color changes at temperatures ranging from 30 to 650° C. Compounds of Cu, Co, Ni, Cr, Mo, U, etc. are used. Changes are due to separation of H_2O, NH_3, or CO_2 or through transitions of ortho salts into pyro salts. Salts developed for the lower temperatures are slightly affected by atmospheric moisture. Suggested uses are to determine surface temperatures of heat exchangers and to locate overheated ports on oil- or gas-fired furnaces. PCR (5)

5a. Ferrous

Hardenability and Hardness Characteristics of Various Steels. Several papers presented at the October 1939 meeting of the Am. Soc. Metals were concerned with various aspects of hardenability and hardness characteristics—the effect of quenching procedure and media, hardenability of several carbon, alloy and tool steels, and hardenability test methods.

Experiments were made by J. L. BURNS & V. BROWN of Republic Steel Corp. ("Time Quenching", Preprint No. 17, 21 pp.) to study the effects produced when the cooling rate of a piece of steel is interrupted during quenching. Three methods were analyzed qualitatively: (a) Simple time-quenching, where the part is quenched in water for a given length of time, then removed and finish-cooled in air, (b) double-quenching, where the part is quenched in water for a given length of time, then transferred immediately to oil to finish the quench; and (c) interrupted-quenching, where the part is quenched for a given length of time in water, exposed to air for a definite length of time, then returned to water to finish the quench. The conditions listed under "a", the simple time quench, produce hardenability curves of the same general shape as straight oil or water quenching, whereas the conditions listed under "b" and "c" produce a differently shaped hardenability curve from the straight oil or water quench, in that under certain conditions the surface hardness is depressed with respect to the subsurface hardness.

The advantages of these methods lie principally in the comparatively tougher outer ring produced under the circumstances of lower stress than would be experienced with the straight water quench, and in obtaining the necessary hardness with structural freedom from free ferrite in the outer part of the piece to be quenched—a condition that would not be obtained with an oil quench. Although time quenching should not be considered a panacea for problems of low hardenability oil quenching steel, or for parts showing a tendency to crack in water, its use can be widened by an understanding of the effect of the stepped cooling rate which results in the time quench.

Not only quench procedure, but variation in the type of aqueous quenching medium can have considerable effect on hardness characteristics, as was demonstrated by F. W. TREMBOUR & HOWARD SCOTT of Westinghouse ("A Test Method for the Evaluation of Aqueous Quenching Media for Steel Hardening", Preprint, No. 18, 19 pp.). Aqueous media are the most active quenching agents available, but suffer from the disadvantage of allowing the random formation of soft spots, particularly on the surface of shallow hardening steels. A test method was developed based on the quantitative measurement of the area of soft spots, formation of which is deliberately induced by heating the quenching bath. The merit of a solution tested is shown to be measured by the bath temperature at which soft spots first appear or are present to a given small degree. Additions of common salt to water (optimum, 9% NaCl) reduce materially the incidence of soft spots and reduce slightly the penetration of hardening. Caustic soda acts in the same manner as common salt except that the optimum concentration is 3%, and the concentration less critical. Contents of sodium chloride and hydroxide near saturation are decidedly harmful, as is 4% of borax or sodium fluoride. That there is an optimum concentration of sodium chloride and hydroxide is attributed to the fact that the beneficial effect of increase in solute concentration, *i.e.,* shortening of the vapor stage, is opposed by the detrimental effect of reduced cooling rate in the fast stage.

Specific data, too numerous to be adequately abstracted, on the hardening characteristics of 16 S.A.E. plain carbon and alloy steels are presented by P. KLAIN & C. H. LORIG of Battelle Mem. Inst. ("Hardness Characteristics of Some Medium Carbon S.A.E. Steels", Preprint No. 22, 39 pp.). The results are summarized in graphs showing conventional hardness penetration curves and tempering curves, the latter plotted to show the change in hardness, for different tempering temperatures, at the surface, at half-radius and at the center of specimens of different diameters, and to show the change in hardness across the section for each tempering temperature. With the water-quenched 0.30 C steels, most of the ½-in. bars showed an abrupt decrease in hardness from the surface to 1/16 in. below the surface and a slight increase in hardness near the center. Of this group of steels (S.A.E. 1045, 2330, T-1330, 3130, 4130, 5130, 6130) 2330 and 5130 are shallowest hardening and 6130 is deepest. Of the oil-quenched steels (S.A.E. 2345, 3145, 3240, 4145, 4340, 4645, 5145, 6145) 2345, 4645 and 5145 are shallowest hardening, 3240, 4340, 3145 and 4145 are deepest, while 6145 occupies an intermediate position. S.A.E. 2330 responded to tempering more readily than the other water-hardened steels, and 2345 was most responsive of the oil-hardened group. In the latter group, 4145, 4340 and 6145 were least responsive to tempering.

Additional data on some S.A.E. steels related to the foregoing are given by GORDON T. WILLIAMS of Deere and Co. ("Hardenability Variations in Alloy Steel—Some Investigations with the End-quench Test," Preprint No. 19, 26 pp.). He shows that steels closely similar in chemical analysis for principal elements may require widely different times at heat before full available hardenability is obtained; possibly this is because homogenization of austenite by diffusion is necessary for maximum hardenability. Failure to consider this time-temperature requirement may result in apparent differences in hardenability among steels of the same type greater than those from type to type after ordinary heating times, and selection of steel may be made on an excessively costly basis. Degree of banding is a possible indication of the ease or difficulty of attaining such homogenization, and it is suggested that the success of the new deoxidizer Grainal (Al-V-Ti) in giving fine grain with intense hardenability may simply be because it promotes homogeneity.

Columbia Tool Steel Co.'s A. J. SCHEID, JR. makes a useful study, similar in range to that of the Battelle workers, of several widely used tool steels, from plain carbon through 18/4/1 ("Hardenability Studies on Tool Steel", Preprint No. 29, 22 pp.). The hardenability values given will be very helpful in the selection and hardening of tool steel. Distortion, commonly evidenced by warpage and shrinking, can be successfully predicted from hardenability curves. Neither tensile, compression nor impact tests on small-size specimens can indicate the properties of the finished, larger tool, but such properties can be predicted from composite hardness readings taken from hardenability curves. In short, the hardenability test when applied to tool steel apparently permits more intelligent selection than any of the other test methods usually applied.

The concept of "hardenability" is thus seen to be the conscious concern of an increasing number of engineers and metallurgists. There is still, however, much controversy over the exact nature or definition of hardenability, and therefore, over suitable methods

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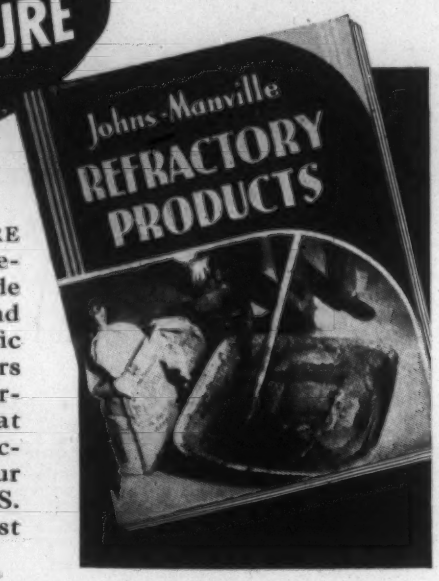

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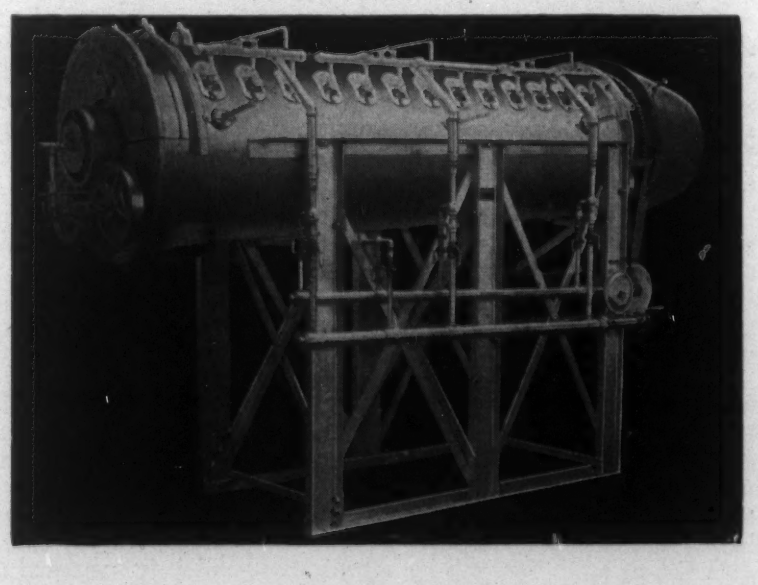

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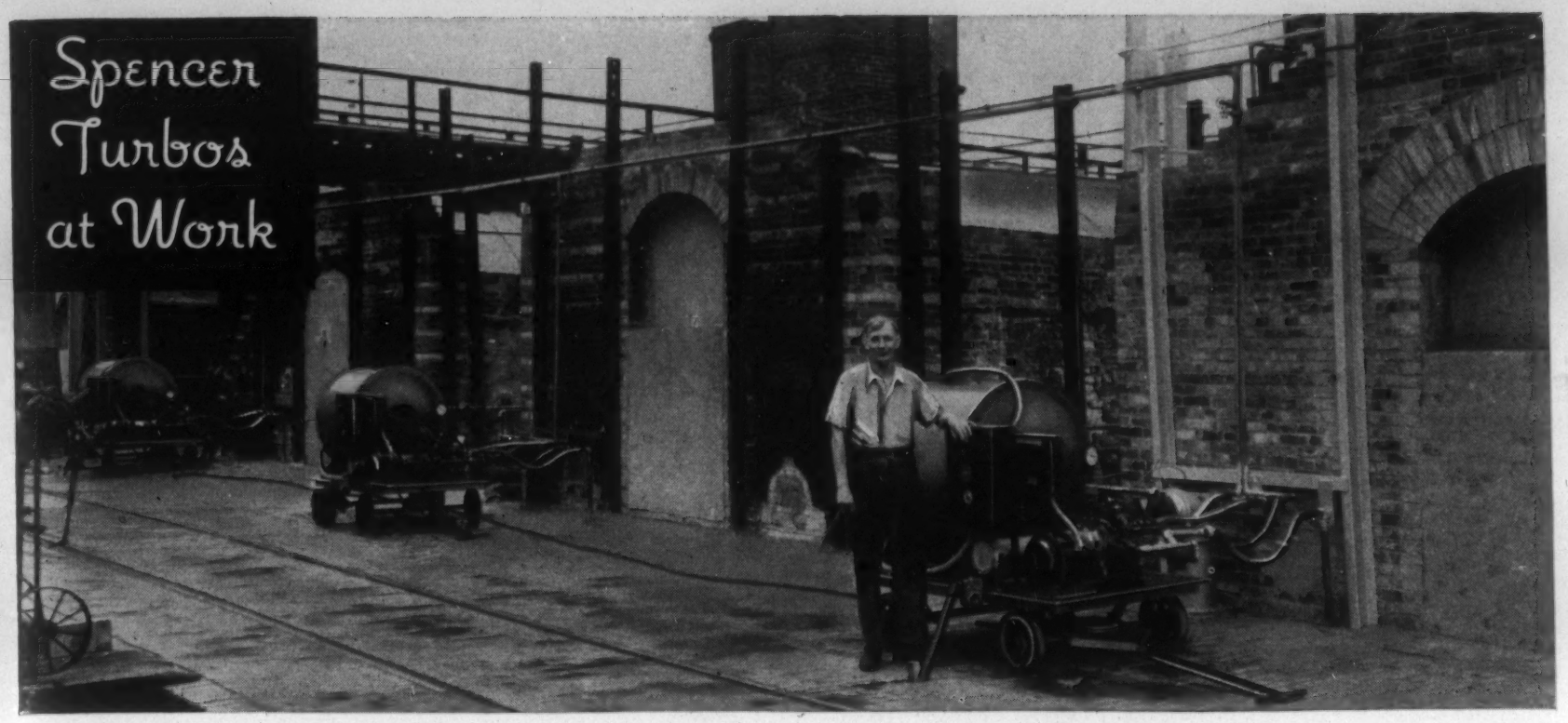
of testing it. Among the foregoing authors, Burns & Brown, Klain & Lorig, and Scheid employed simple transverse hardness tests across a section of the specimen to determine surface hardness and depth of hardness, the cross section tested in each case being selected as far from the ends of the heat treated specimen as possible. Scheid also studied mass effect by preparing 4 different sizes of specimen for each steel. Williams, of course, used Jominy & Boegehold's end-quench hardenability test, in which hardness is tested along a specimen quenched on one end only, so as to reveal, on one test bar, the hardening produced by a range of cooling rates representing every condition from that at the surface of a small bar drastically quenched to that at the center of a round bar several in. in diameter quenched in oil. Much of Williams' paper is devoted to an evaluation of this test, and he shows that the method is non-critical as to length or diameter of specimen, and is only slightly affected by temperature of the water. The test has one limitation, though; shallow-hardening carbon steels develop such a narrow martensitic band that accurate discrimination is difficult and it is suggested that the major application of the test is to deeper hardening steels.

In a new paper, however, W. E. JOMINY ("A Hardenability Test for Shallow-hardening Steels", Preprint No. 20, 14 pp.) presents a variation in design of test bar that is said to make the method as useful for testing the hardenability of shallow-hardening steels as of carburizing and oil-hardening steels. The new test bar is 2 in. long and 1 in. diam., but its most important feature is the shape of the tapered 1-in. long hole cut in the end, which produces a wall thickness of 3/32 in. at the extreme end, increasing to ¼ in. at the top of the hole. The test specimen is heated to whatever hardening temperature is desired, then hung vertically in a fixture, and water at 75° F. is sprayed into the hole at the end. (5a)

Introductory Study of the Nitriding of Hardened High Speed Steel by the Use of Molten Cyanides. J. G. MORRISON & J. P. GILL. *Preprint, Am. Soc. Metals,* Oct. 1939, 76 pp. Exhaustive research. The use of molten cyanides for the nitriding of hardened high speed steels is older than is generally recognized, and considering the present wide application of the process, it is surprising that only brief descriptions of the operation have appeared in print. Today practically every manufacturer of high speed steel tools uses the process to a varying degree and, in most instances, with considerable benefit to the product. The process, as usually conducted, consists of immersing the hardened and tempered tool or the hardened, tempered and ground tool in an aged molten mixture of sodium cyanide and potassium cyanide. The temperature of the salt is usually within the range 1000°-1050° F. and the time of immersion may be from 5 min. to even 1 hr. or more, resulting in an extremely shallow case which has a hardness greatly in excess of that of hardened high speed steel. It was early found that the use of freshly prepared mixtures of sodium and potassium cyanide produced tools having very brittle edges, but when the same mixture was aged for a considerable length of time it produced tools relatively free from harmful brittleness.

For practical purposes a new bath is usually made of 60% sodium cyanide and 40% potassium cyanide, as this ratio has a melting point quite close to that of the eutectic. "Salting out" of carbonate as the bath temperature falls below 925° F. causes a change in the composition of the liquid portion. A freshly prepared mixture after the initial fusion (and provided the temperature of the salt has not exceeded 1100° F.) will show a cyanogen content of approximately 45% as compared to a theoretical cyanogen of 47.8% for pure salts. A thoroughly aged bath will be entirely liquid at approximately 925° F. and will remain liquid to 775° F., the carbonate that separates as the temperature drops below 925° F. settling to the bottom of the pot. A thoroughly aged bath will contain about 24% cyanogen. A bath which has been in use for a reasonable length of time will contain the following, if nickel alloy pots are used: NaCN, KCN, NaCNO, KCNO, Na_2CO_3, K_2CO_3, small amounts of tungsten (as tungstates), about 0.10% iron, about 0.10% nickel, and free carbon in the nickel-containing sludge adhering to the bottom and sides near bottom of the pot.

The aging of a new bath if contained in a pressed steel pot requires considerable time if the temperature of the bath is not permitted to exceed 1100° F. In a nickel alloy pot aging is more rapid than in a pressed steel pot. A freshly prepared bath of 60% NaCN, 40% KCN contained in an 8-in. diameter by 12-in. pressed-steel pot was heated the first, second, fifth and thirteenth days to 1050° F. and held 2 hrs. at heat each time. Between each heating the bath was covered with a sheet metal cover. On the thirteenth day the cyanate content had increased from the 1.03% of the first day to 1.93%. On the fourteenth day the bath was heated to 1300° F., cooled to 1050° F. and held 2 hrs. at this temperature. The cyanate increased to 2.74% as compared to 1.93% for the previous day. The higher temperature appears to accelerate the formation of cyanate, although too high a temperature results



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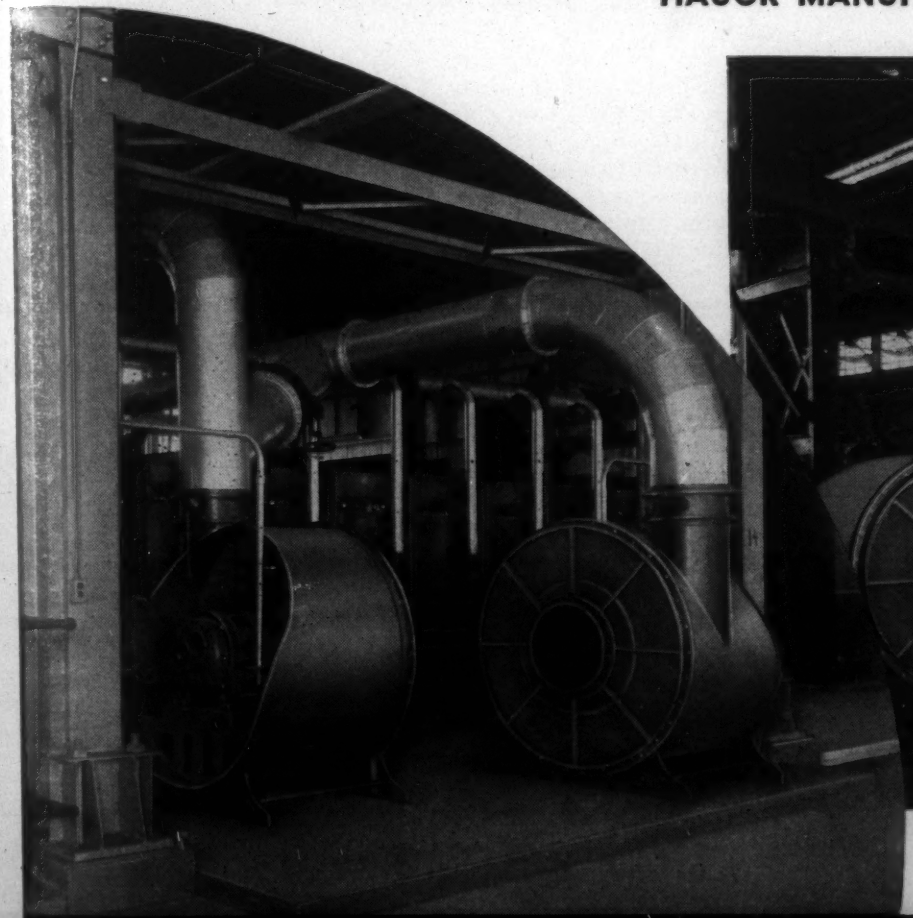

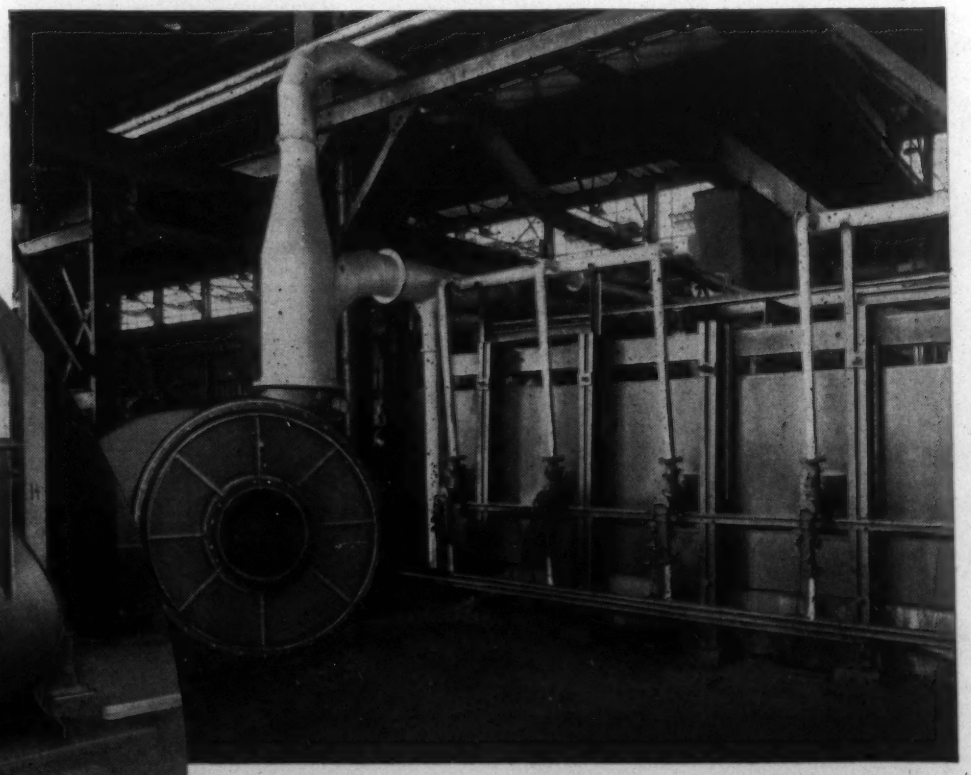

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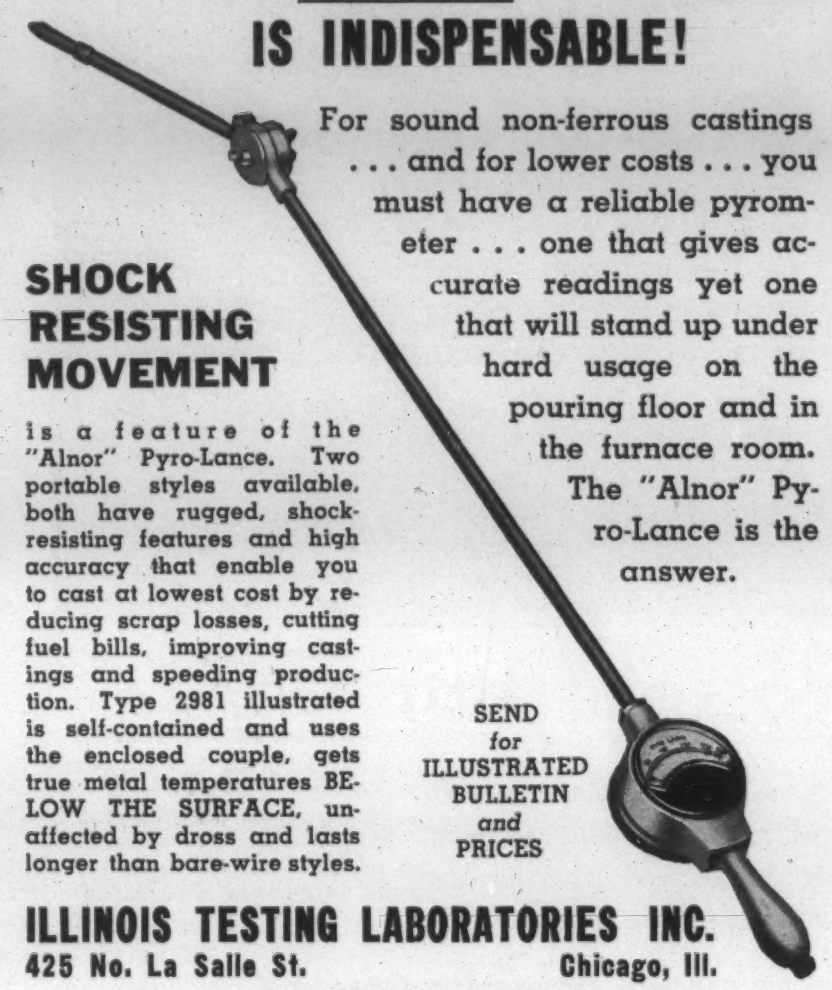

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in a further decomposition of cyanate. The most practicable method to avoid "blowing" during heating-up is to use a secondary cover consisting of 2 circular pieces of sheet metal between which is placed ½ to ¾ in. of an asbestos wall board. This cover having 3 lugs is placed on the inside of the top of the pot clearing the molten salt level by 1 in. and not interfering with the regular pot cover. This added insulation permits the top crust to soften early enough so that it offers little resistance to the expanding gases.

A study of the contamination of the bath by nickel showed this contaminant to be somewhat detrimental. The change to the use of a nickel-free bath was accompanied by a marked general improvement. There is ample evidence that nickel was plating on the surface of the specimens when the bath was nickel contaminated. It is quite obvious that such an effect would result in inconsistencies. The chief source of nickel contamination is the nickel alloy pot. An investigation of the galvanic action taking place between the bath, the pot and the samples, showed a negative polarity on immersion, indicating the sample to be anodic, a variable but rapid recovery to a relatively high positive polarity in which the immersed sample became the cathode, and then a decreasingly rapid drop in millivoltage to an approximate constant positive millivoltage.

Nitrogen determinations indicate, with 30-min. immersion periods in an aged bath between the temperature of 850 and 1150° F., that the major portion of the nitrogen is within the first 0.001 in. of the surface. The brittleness of the surface of high speed steel that has been nitrided in a freshly prepared bath is apparently due to the steepness of the nitrogen gradient rather than to the amount of nitrogen that is present. When the material is held a considerable period of time in a freshly prepared bath the nitrogen diffuses deeper, the gradient is not so sharp and the surface is not unusually brittle. The process should never be used when the surface is decarburized, because of the brittleness that results. Slight softening of the surface from grinding prior to nitriding is not detrimental.

There appears to be no material difference, in the amount of nitrogen that is absorbed, between a piece of hardened high speed steel and a piece of annealed high speed steel. The surface hardness of annealed high speed steel is increased to about the same hardness as the surface of hardened and tempered high speed steel when the annealed steel is subjected to the nitriding treatment. This can be explained by the fact that the depth of the hardened case resulting from a short immersion period is so extremely shallow that when it is tested by a file the surface is broken even with a very light pressure. Under certain conditions the surface of the steel will have a sooty appearance and it may appear that there has been carbon absorption. The carbon content, however, is confined to the surface but may be entrapped near the surface by a nickel deposit, if the bath is nickel contaminated. Underneath this surface there does not appear to be a carbon absorption as the result of nitriding.

It has been found possible to adopt the Knoop method of hardness testing to obtain the surface hardness of nitrided high speed steel. A surface hardness equivalent of over 1100 Brinell appears possible by properly nitriding fully hardened high speed steel. By careful observation of the surface of the nitrided material deductions may be made as to whether the process is operating properly. (5a)

The Spheroidizing of Steel by Isothermal Transformation. P. Payson, W. L. Hodapp & J. Leeder (Crucible Steel Co.) *Preprint, Am. Soc. Metals,* Oct. 1939, 24 pp. Review plus research. Traditional methods for spheroidizing steels involve very slow cooling, or very long subcritical heating, or both. The new method developed by the authors depends on causing the steel to transform at a selected constant temperature, and requires only a fraction of the time ordinarily expended in spheroidizing. Experience with many tons of steel annealed by the method on a commercial scale has proved that the new principle is entirely practical.

Although many recent discussions on the momenclature of the aggregates of ferrite and carbide have stressed the formation of lamellar pearlite as the primary product of the transformation of austenite at high temperatures, it is shown here that spheroidal carbides are formed directly from austenite, if the temperatures to which the austenite is heated, and at which it is subsequently allowed to transform, are carefully controlled. The steels studied are plain carbon steels with carbon varying from 0.33 to 1.16%. The new procedures for spheroidizing steels are based on these observations, and practical annealing cycles requiring much shorter furnace times than those now in use have been developed. The new cycles involve heating to a temperature over the critical for the steel, cooling at a convenient rate to a temperature not far below this critical, holding for a necessary time at this temperature, then finish cooling in air. The total furnace times required, for small furnace charges, are about 6-20 hrs., depending on the grade of steel.

With a 0.46% C steel, for example, the following annealing

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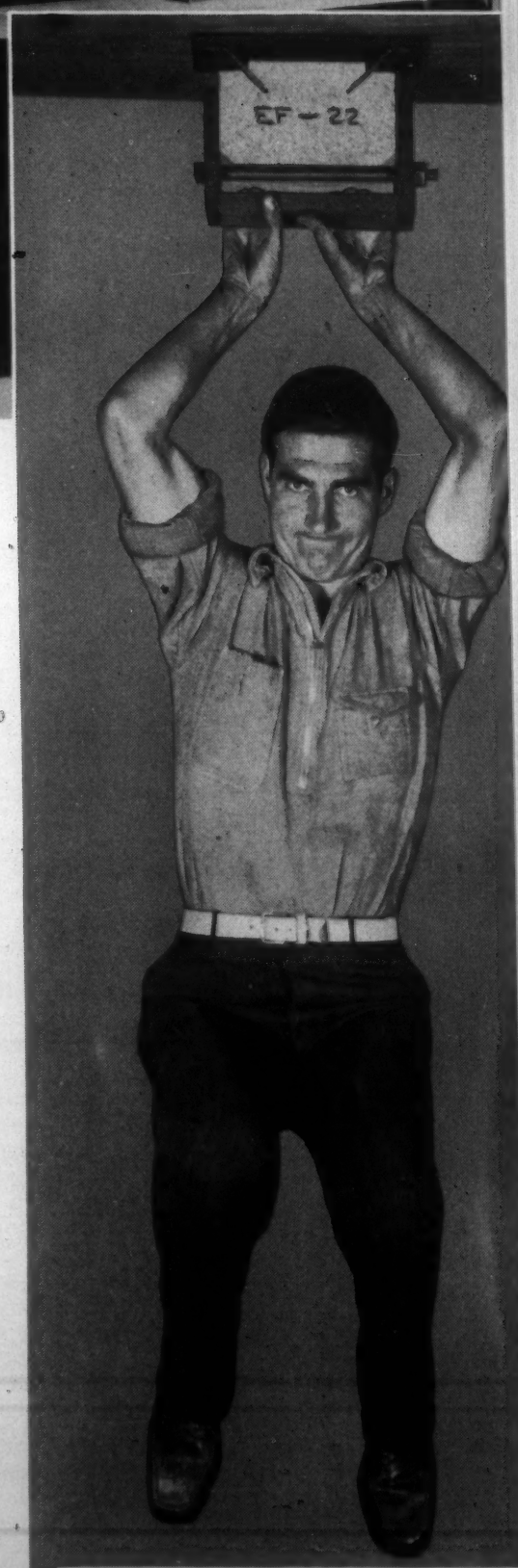

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procedure was found suitable for producing a spheroidal annealed structure: Heat 2 hrs. at 1340° F.; raise temperature to 1370° F., hold I hr.; cool to 1310° F., hold 8 hrs.; finish cool in air. The structure contained less than 1% lamellar pearlite and the hardness was 134 Brinell. Higher-C steels spheroidize faster, within the range where only a spheroidal product is formed, so that the initial subcritical 2-hr. heating given in the foregoing schedule is not required with hypereutectoid steels. (5a)

Annealing in Boiler and Apparatus Construction. Effect of Normalizing and Annealing (Spannungsfreiglühen im Kessel- und Apparatebau. Die Wirkung von Normalisieren und Spannungsfreiglühen) E. SCHULTZ & O. NIEZOLDIE. *Arch. Warmewirt. u. Dampfkesselbau,* Vol. 20, June 6, 1939, pp. 141-146. Original research. Experiments on normalized and annealed fusion welds show that notable differences in mechanical properties do not exist, although the structures do differ. The initial stresses are relieved to a large extent in both cases. The normalized weld possesses somewhat better deformation properties and, in general, smaller differences in hardness between seam, transition zone and base material. Under suitable welding conditions the annealed samples possessed even better deformation values than those similarly welded, but normalized. Grain growth due to recrystallization in the transition zone of annealed seams could not be found. The toughness of normalized and annealed samples was about equal. Formation of "free" cementite need not be feared. Normalized or annealed seams behaved practically alike when exposed to NaOH and feed water. The transition zone of the annealed seams is no more sensitive to corrosion than the base material. The authors state that with the boiler materials tested, (0.20% C, 0.25 Si, 0.55 Mn, 0.02 P, and 0.03 S) annealing brings about sufficient quality improvement so that both types of heat treatment may be considered alike. GN (5a)

Carburizing and Heat Treatment of Chromium-molybdenum Case Hardening Gear Steels (Zur Kohlung und Wärmebehandlung von Getrieben aus Cr-Mo-Einsatzstählen) HUBERT H. MEINGAST. *Durferrit Mitt.,* Vol. 8, July 1939, pp. 66-119. Research. The results of wear, shifting and driving tests on a specially devised testing apparatus substantiate the conclusions on heat treatment previously given (See also *Metals and Alloys,* Vol. 10, July 1939, p. MA416 R/1), namely that a single hardening guarantees a better toughness than double-hardening or merely hardening the carburized zone. Diffusion annealing aiming at coagulation of the carbides is not required. In general, drawing is also not necessary. These practical tests further showed that the brittleness is essentially decreased by the smaller depth of case resulting from this heat treating method. Decrease of the depth of carburization is also advantageous because warpage is decreased to a minimum. GN (5a)

Nitriding Austenitic Steels. G. F. KOSOLAPOV. *Metallurg,* Vol. 14, June 1939, pp. 54-60. In Russian. Research. Austenitic steels containing large amounts of Cr, Mn, and other alloying elements were nitrided and the structural changes in the nitrided layer were studied by means of X-rays. In order to obtain the greatest hardness in the austenitic steels the nitriding temperature should be higher than for steels having α phase in the original condition. The diffusion of nitrogen in the austenitic steels proceeds more slowly than in steels with α phase. The structure of the γ phase in the nitrided layer of most austenitic steels is not retained but decomposes into α phase and nitrides. The hardness of the nitrided layer of high-alloy steels is equally determined by distortion of the lattice and the precipitation of nitrides in the disperse form. BZK (5a)

Recrystallization of Stainless Steels of the 18-8 Type by Annealing after Cold Work (La Recristallisation des Aciers Inoxydables du Type 18-8 par Recuit après Ecrouissage) J. VIALLE. *Rev. Mét.,* Vol. 36, June 1939, pp. 288-297. Research. When cold worked, 18-8 undergoes a phase change as the unstable austenite forms martensite with an appreciable increase in hardness. This hardness is virtually unchanged by heating for 1 hr. at temperatures up to 500° C., but is slowly decreased by heating at 500°-800° C. (the slowness may be attributed to the strengthening effect of carbide precipitation), while above 800° C. the decrease is rapid. Slip lines in cold worked specimens were determined by heating for 20 min. at 700° C. to allow the carbides to precipitate on the slip lines and grain boundaries, then etching in 20% oxalic acid. This method showed very clearly whether or not cold worked and reheated samples had recrystallized. Three dimensional diagrams show the relationship between recrystallization temperature (1100°-1200° C.), amount of cold work (% elong.), and grain size after recrystallization for 3 heats of 18-8.

In general, for a given recrystallization temperature between 1100° and 1200° C. (holding time at temperature 30 min.), the grain size decreased with increasing amounts of cold work (5-40%); for a given amount of cold work, the grain size increased with increasing recrystallization temperature. At the temperatures involved, recrystallization was accomplished and grain growth started within 2 min. The initial grain size before cold work had very little effect on the final grain size after cold work and recrystallization. To see if there was any difference among various heats with respect to susceptibility to grain growth, samples from 36 heats were water-quenched from 1100° C., cold drawn 40%, then reheated to 1100°, 1150°, and 1200° C. There was no apparent correlation between the marked differences in grain size and composition, since very similar heats often displayed varying grain sizes after recrystallization. Even small amounts of titanium (0.25% Ti, for example) greatly refined the structure. JZB (5a)

5b. Non-Ferrous

The Effect of the Number of Quenchings and Annealing Time on the Precipitation Hardening of Aluminum-copper-magnesium Alloys (Der Einfluss der Zahl der Abschreckungen und der Glühdauer auf das Aushärten von Aluminium-Kupfer-Magnesium-Legierungen) P. BRENNER & H. KOSTRON. *Luftfahrtforschung,* Vol. 16, July 20, 1939, pp. 362-369. Original research. Sheets of 2 and 8 mm. thickness of the German Al-Cu-Mg alloy Bondur 17/65 (analysis not given) were annealed up to 450° C., then homogenized in a salt bath at 505° C. for various periods of time (up to 100 min.), quenched and stored for 7 days at room temperature. The lattice constant changes in an asymptotic manner with annealing time while the final (higher) tensile strength value is reached much more slowly than the final lattice constant. Elongation increases with progressive homogenizing. One set of samples, homogenized at 505° C. for various times and then tempered at 300° C., showed a pronounced effect of the annealing time at 505° C. on aging behavior. This was attributed to primary precipitation of $CuAl_2$.

The effect of 1-9 quenchings on the room temperature hardening of Bondur 17/39 (4.38% Cu, 0.39% Mn, 0.93% Mg, 0.54% Si, 0.44% Fe) was studied. No correlation between incubation time and homogenizing time was found. Tensile and hardness tests yielded the same results. When applying homogenizing times of 15 min. and longer, the number of quenchings had no effect on the course of precipitation. With reference to equal total homogenizing times, the course of precipitation is not affected, irrespective of whether the total homogenizing times are interrupted by second quenchings. This holds as long as no essential part of the homogenizing time is absorbed by the heating-up to temperature. EF (5b)

6 Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

E. V. DAVID, SECTION EDITOR

6a. Ferrous

Fundamental Nature of Welding. I, the Effects of Heating Velocities, Carbide Diffusion and Carbide Melting in Electric Spot, Flash and Resistance Welding. DONALD E. BABCOCK (Mellon Inst.) *Welding J., N. Y.*, Vol. 18, Aug. 1939, pp. 477-479. Research. Reference is made to the equilibrium diagram to establish the difference between equilibrium conditions and conditions during welding in which the rapidly changing temperature-time cycle permits non-equilibrium reactions. In the small volume of heated metal of the weld it is considered possible to have a ferrite sponge in which the interstices are filled with molten austenite containing the carbides, melting at a low temperature because of the localized high carbon concentration. In the pressure stage of the welding operation the liquid in the ferrite sponge is considered to be squeezed out thus resulting in weld metal of higher ferrite concentration than the original base metal. While being squeezed out the carbide-rich liquid is rejected to cooler parts of the weld, where segregations of cementite are formed from the carbide in excess of pearlite carbon content. This cycle is believed to be due to lack of time for diffusion to establish equilibrium conditions. A micro is shown etched with sodium picrate which is intended to indicate presence of the cementite. Microchemical tests indicate loss of C at weld area and the statement is made that oxygen analyses indicated that deoxidation had occurred during welding—thus apparently eliminating oxygen as the cause of decarburization. WB (6a)

Welding in Reinforced Concrete (La Soudure dans le Béton Armé) M. LEBRUN, J. ETEVE. *Usine*, Vol. 48, July 6, 1939, pp. 33 (two brief articles). The reinforcing bars in concrete were welded both by electric arc and with oxyacetylene flame, instead of being held together by wire as ordinarily. This procedure is considered preferable, especially for large pieces and beams. Costs were about 10-15% lower for the oxyacetylene process than for arc welding. Welded reinforcing bars are also considered to give greater strength to the whole structure. Ha (6a)

Welding Electrodes. HUGO W. HIEMKE (U. S. Navy Dept.) *J. Am. Soc. Naval Engrs.*, Vol. 51, Aug. 1939, pp. 312-339. Review plus data compilation. The development of the heavily-coated welding electrode is surveyed and available information is tabulated on behavior in welding, and weld metal properties with the present electrodes. The difference in properties of the weld metal deposited by bare wire and heavily coated electrodes are shown to be ascribable to the absence of oxides and nitrides in weld metal from the latter. The coating is efficient in producing a gaseous shield of carbon monoxide and hydrogen which protects the molten metal against oxidation and absorption of nitrogen during transfer. The slag from the coating also performs a fluxing action and refines the deposited metal. The all weld metal tension test is considered the most important test of the electrode and is usually made in the as-welded condition. This test is least affected by the properties of the base metal, and the operation of stress relieving has little effect on the evaluation of electrodes. New research information is shown in a number of curves for the effect of base metal preheat temperature on tensile strength, yield point and elongation of weld metal indicating that an increase in preheat temperature from 60° to 350° F. is accompanied by a considerable increase in ductility. Other curves show effect on weld metal properties of different deposition techniques, among them 27 passes for one weld using string beads, 17 passes using weaving technique of 1-2 diameters, and 10 passes using latter technique of 2-4 diameters. The ductility of the weld metal increased in the order named. No significant effect on elongation could be found from aging of the weld metal.

A range in ductility was obtained for the weld metal deposited under conditions which were considered to be uniform; distribution of elongation values over such a broad range (12-22%) is believed to be due to the same phenomenon that causes "fish eyes" to appear in the fracture surface of the tension test. The author states that this is not indicative of defective weld metal since stress relieving eliminates the fish eyes. The phenomenon is believed to be due to local tension fracture occurring at an inclusion or blowhole and may also be associated with locked-up stresses. The low-alloy steel electrodes for welding high strength, low-alloy steels may give slightly lower ductility than carbon steel weld deposit. It is desirable to determine ductility through the entire temperature range of welding and cooling, down to room temperature. For this purpose the weld cracking test is made on a specimen, designed by Swinden and Reeve, which is fully restrained while welding. The weld is then sectioned and examined for cracks. The properties of deposited metal from electrodes of stainless and heat resisting alloy, hard facing alloy, electrodes for cast iron welding and non-ferrous alloys are briefly reviewed. WB (6a)

6b. Non-Ferrous

Welding Non-ferrous Metals. Even though (as the author of one of the articles digested herewith states) there appears to be a paucity of data on the welding of specific non-ferrous metals, taking in the entire field in one bite seems like a tremendously big mouthful. Yet two recent articles have each attempted to do just that, one in 4 pages, the other in 46.

Some of the high spots in non-ferrous welding progress and a few unsolved problems are reviewed by L. ROSTOSKY ("Fortschritte im Schweissen von Nichteisenmetallen", *Maschinenbau Betrieb*, Vol. 18, July 1939, pp. 345-348). Thus, pure Zn may be welded instead of soldered, and galvanized sheet successfully welded with Zn as filler metal, yet no final solution has been found to the problem of welding Zn die castings. The great heat conductivity of Cu causes difficulties when welding it. A solution to this problem, when it is really serious, is in the use of "hose" electrodes with a gas stream protecting the metal from oxidation and forcing the metal in a fine stream off the electrode. With increasing Al and Fe content the welding of Al-bronze becomes more difficult. Repair work on red brass is often done with filler metal made from corresponding scrap, but the specific analysis has to be carefully considered. A mold is sometimes made for the weld as such repair welding is similar to a regular casting process. Gas absorption is an important factor in Ni welding. In case of Ni-plated steel, several layers have to be welded in order to avoid the inclusion of Fe in the weld. This practice, however, is unnecessary in the case of Cu-plated steel, as the melting points of Cu and steel are sufficiently far apart. Al is welded in most cases by the gas method, but electric welding is making progress. For heavier pieces the metal-arc process is preferred, while for thin sheets and profiles spot welding is applied. A new method uses two C electrodes working on both sides of the flanged seam, which contains the flux. Mg alloys are welded by the autogenous method. The flux serves the dual purpose of dissolving the oxide film and of protecting the molten metal from ignition. Some Mg alloys can stand only short welds because they become brittle in the heat.

Much more comprehensive, although possibly of somewhat less immediate practical value is a meaty "correlated abstract" by E. G. WEST ("The Welding of Non-ferrous Metals—a Review of Published Information", *Trans. Inst. of Welding*, Vol. 3, Apr. 1939, pp. 96-141). The review, a compendium of information on the subject in text books, research reports, other reviews, etc., is well planned so as to make the information easily available under the headings (1) Welding Processes, (2) General Problems of a Fundamental Nature, (3) Methods of Testing Welded Joints, and (4) Technique and Applications. It is further divided into subheads, and under Technique and Applications these are Al, Cu, Ni, Pb, Ag, Mg and Zn. There appears to be a paucity of data on the non-ferrous metals specifically, but many of the general articles on welding of ferrous materials deal with fundamentals that are applicable to non-ferrous welding. Tabulated data are presented for the physical properties of the non-ferrous metals and high temperature tensile properties of Al, Cu, Ni and Zn. Curves are given for high temperature tensile and impact properties of arsenical Cu, deoxidized-arsenical Cu, non-As Cu, deoxidized non-As Cu. In section 2 on General Problems the subjects discussed are evalution of weldability; shrinkage, internal stress and distortion; variation of physical properties with temperature; effect of heat on the parent metal; and chemical and physico-chemical reactions. Author and subject indices make the information quickly available for reference. X (6b)

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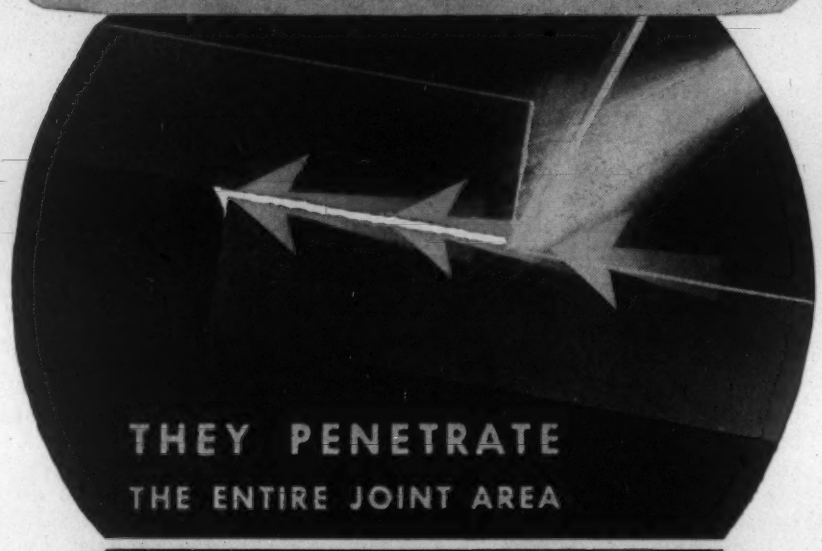

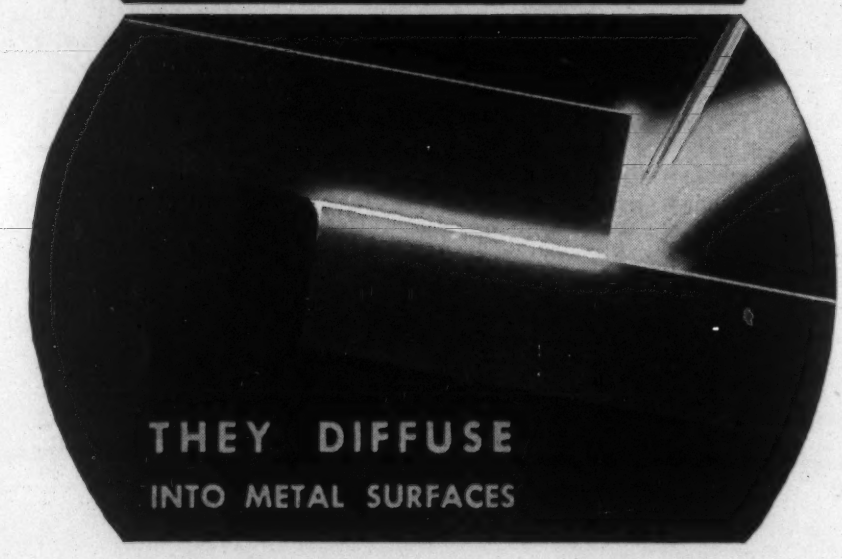

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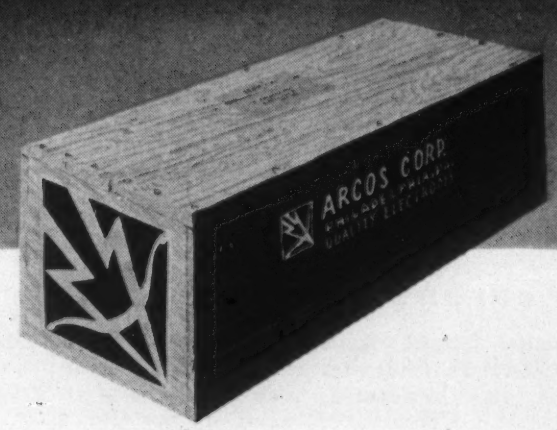

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7 Finishing

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H. S. RAWDON, SECTION EDITOR

Modern Metal Colouring. CHARLES HARRIS *J. Electrodepositors Tech. Soc.*, Vol. 15, 1939, pp. 97-108. Practical. The surface condition of the metal is of importance. A smooth surface is necessary if the coloring is due to light interference of thin films. Scratch-brushed or sand-blasted surfaces are useful when dense or dead coloring is required. The methods of coloring metals may be grouped under 3 heads: (1) Chemical methods; (2) heating methods; (3) electrolytic methods. Cu and its alloys are colored brown by a $Cu(NO_3)_2$ solution, from which traces of sulphate must be absent, and are colored black by an ammoniacal copper carbonate solution. Formulas are also given for green finishes. Steel is colored black by immersion in a solution containing NaOH, 400 g/l.; KNO_3, 10 g/l.; $NaNO_3$, 10 g/l.; heated to 120° C. Cd is colored black by a solution containing $KClO_3$ and $CuCl_2$, and is colored brown by a solution containing $K_2Cr_2O_7$ and dilute HNO_3. Brown and black colors on Al and Zn can be obtained by immersion in a molybdate solution. Steel is heat bronzed by immersion in fused $NaNO_3$. Cr, Cu, and Cu-Sn alloys can be colored by heating in air or by immersing in fused salt baths. Sn can be colored black by an anodic treatment in an acidified phosphate bath, and Mg alloys by anodizing in a bath containing a dichromate and a phosphate. The following methods of metal coloring are also discussed: dyeing anodic films on Al; electrodeposition of black Ni; the electrocolor process which uses cathodic treatment in an alkaline Cu lactate bath.

AB (7)

7a. Electrolytic Methods

Electrolytic Deposition of Zinc at High Current Densities. N. P. DIEV & L. E. GUREVICH. *Tsvetnye Metal.*, No. 10, Oct. 1938, pp. 75-84. In Russian. Experiments were conducted for the purpose of developing an electrolyzer for producing electrolytic zinc as a continuous sheet (strip). The possibilities of increasing the cathodic current density without impairing other technical characteristics, as compared to standard processes, were investigated. With increasing current density in the range of 4000 to 6000 amps./m.^{2} the output increases. With increased acidity the cathode current efficiency decreases only slightly. The highest cathode efficiency is obtained with the concentration of 70-120 g. Zn/l. of electrolyte. With Zn concentration above 120 g./l., and higher current densities, a coarse crystalline and uneven deposit is obtained. This creates conditions causing discharge of hydrogen and chemical corrosion of Zn. The cathode efficiency is thereby decreased. Of the colloids added to the electrolyte, glue was found to produce the best results; with 0.1-0.2 g. of glue/l. the current efficiency was 74 to 79%. The next best colloid is gelatin, 0.3 g./l.

An empirical formula for calculation of potential in the electrolyte, using 5000 amps./m.^{2} current density, 80 to 120 g. Zn/l. of electrolyte, 150 g. acid/l. and 2-5 cm. distance between the electrodes was developed: $V = 3.1 + 2 \times 10^{-6} C_{Zn} D - 3 \times 10^{-3} C_{H_2SO_4} + 12 \times 10^{-5} aD$, where C is concentration in g./l., a is distance, and D current density in amps./m.^{2} It was possible to keep the energy consumption within the usual 3100-3300 kw.-hrs.; owing to increased acidity with energetic agitation and to bringing the electrodes to within 2 cm. it was possible to produce compact Zn deposit in spite of high current density (up to 4000 amps./m.^{2}). Analysis of gases produced with high current density (4000 amps./m.^{2}) in an hermetically sealed bath showed a possibility of obtaining oxygen-rich gas (83% O_2), *i.e.*, for each ton of Zn about 0.2 ton of oxygen. Experiments with a bell above the anode in an hermetically sealed bath did not result in any improvement of the gas composition because gas bubbles partially migrate with the electrolyte from one electrode to the other. The feasibility of obtaining a continuous deposit in the form of strip (40 cm. wide) was demonstrated. This was obtained by stripping off the deposit from a rotating drum cathode as it emerged from the electrolyte.

BND (7a)

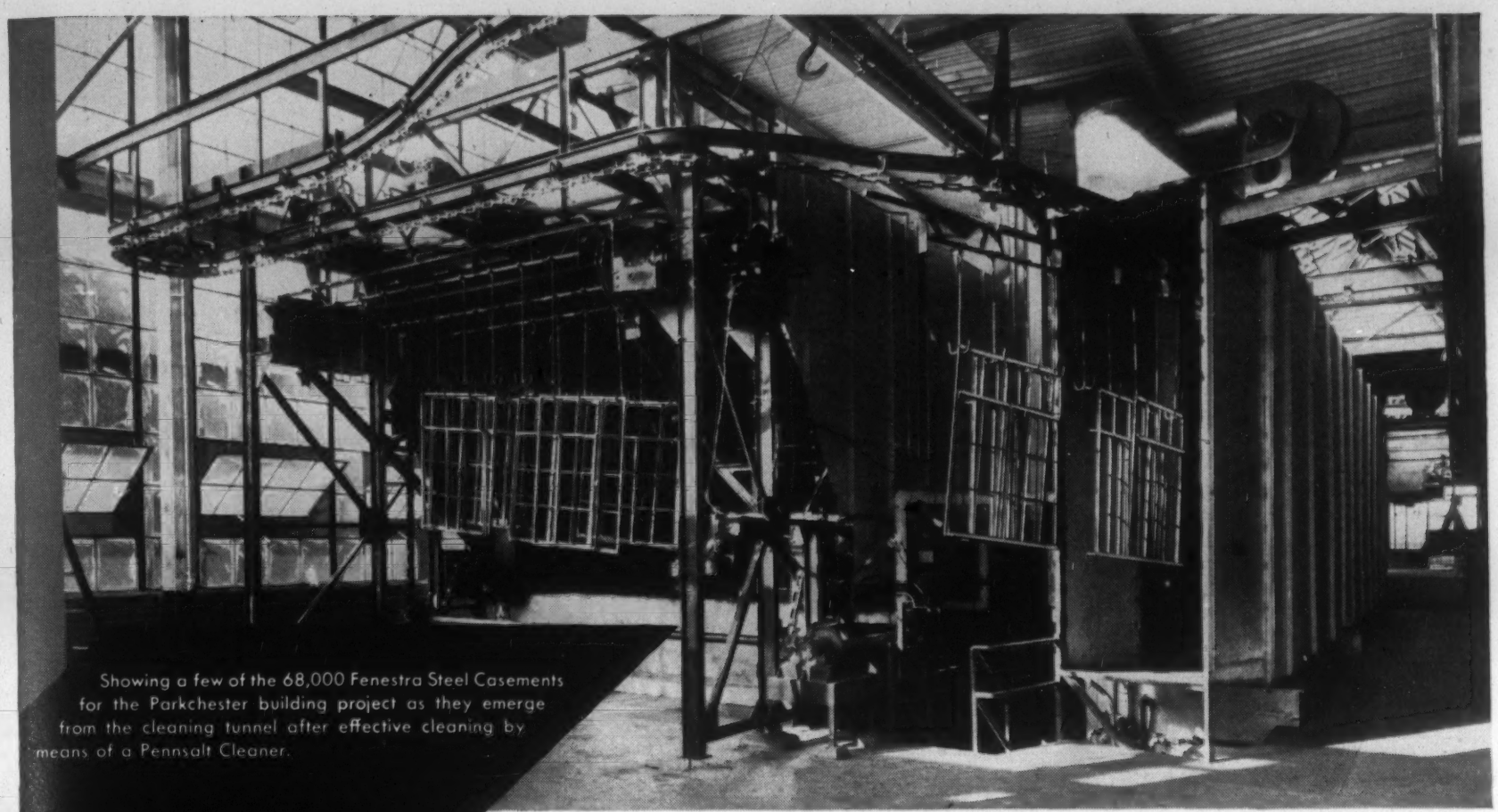
Anodic Oxidation of Aluminum and Its Alloys. The extent to which the development and increasing application of anodic oxidation of aluminum and its alloys have expanded the useful field of aluminum has been emphasized in a recent article in this magazine (F. KELLER, G. W. WILCOX, M. TOSTERUD & C. J. SLUNDER, "Anodic Coating of Aluminum—Behavior of Alloy Constituents," *Metals and Alloys*, Vol. 10, July 1939, pp. 219-225). This article demonstrated that the different constituents oxidize differently, and that these varying characteristics determine to some degree the color, operation and other results obtained when various Al alloys are anodically oxidized. Recent articles elsewhere have reviewed this general field and given specific attention to suitable electrolytes, the importance of thickness, and methods of coloring the films.

An excellent review of the subject, with particular reference to sulphuric acid processes, is given by J. D. EDWARDS of Aluminum Research Labs. ("Anodic Coating of Aluminum," *Monthly Rev. Am. Electroplaters' Soc.*, Vol. 26, July 1939, pp. 513-532). The color of films depends on the purity of the aluminum. Films on pure aluminum produced by the H_2SO_4 process are transparent and glass-like. Additions such as Si, Cr, Mg and various other alloying constituents give colored films. The oxide coatings are usually uniform, but streaking may result from the structural characteristics of the original aluminum ingot. It is difficult to match the appearance of anodized aluminum for a structure made of several members, as alloys and welded joints produce variously-colored films. The oxide coating occupies a greater volume than the Al from which it is formed, so that there is an increase in the thickness of a specimen. The current efficiency of anodizing is about 100%, but some of the metal may dissolve during the process. Colored coatings can be prepared by precipitating colored pigments [usually organic dyes for which $Al(OH)_3$ is a mordant] in the pores of the anodized film. Dyed oxide coatings retain their appearance indefinitely indoors but gradually fade on out-of-doors exposure. Coatings can be impregnated with photosensitive salts and photographs reproduced thereon.

As removed from the bath, the coatings are porous, and must be sealed by treatment with boiling water or hot solutions of Ni or Co acetate; the coatings may also be impregnated with oils or waxes. The coatings show "crazing" after bending, but do not flake off. The mechanical properties of a specimen are not appreciably affected by the presence of an oxide coating. The reflectivity of Al is reduced by oxide films, the reduction being greater the thicker the film. However, by certain brightening processes, an oxide coating 0.2 mil. thick can be made which will have a reflectivity of 80-90%. The coatings are stable to heat, but they craze on heating to 300°-400° F. The dry coating is a good dielectric; a sealed coating 0.5 mil. thick may have a breakdown value of 500-600 volts. Anodized coatings have considerable atmospheric corrosion resistance, which is increased by sealing with a dichromate solution. The coatings form a good base for paint; the usual procedure consists of applying a zinc chromate primer and then a top coat containing Al pigment.

Anodic oxidation of aluminum can also be accomplished in chromic acid or oxalic acid electrolytes. J. W. CUTHBERTSON ("The Anodic Oxidation of Aluminum," *J. Inst. Metals*, Vol. 65, 1939, Adv. Copy No. 840, 23 pp.) has studied performance and results obtained in a number of different electrolytes, using cathode-ray oscillography. The effect of the oxide barrier on the form of the current-time and current-voltage curves was investigated and shown to depend on the constitution of the electrolyte and operating conditions. Because of capacity effects the current and voltage are always out of phase during the whole or part of each cycle. The current-voltage curve consequently is a closed loop, the area of which is proportional to the dielectric loss in the film. The results suggest that while the mechanism of anodic oxidation in chromic, sulphuric and oxalic baths is similar, chromic acid solutions should produce the more satisfactory films.

A modification of the chromic acid process is described in an



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article (in Russian) by F. V. KOZLENKOV ("Anodizing Aluminum and Its Alloys," *Aviapromyshlennast,* No. 6, 1939, pp. 32-38). Up to 1938 the Eloxal (oxalic acid) and Bengough-Stuart (chromic acid) methods were widely used in the Soviet Union, but since then some plants have adopted a modified and more rapid method of anodization in a 10% chromic acid solution. The work is first degreased, then washed in running water and subjected to anodic oxidation for 30 min. at a constant e.m.f. of 40 v., a current density of 0.3-0.4 amps./dm.^{2}, and a temperature of 37±2° C. Oxide films of good quality are obtained when the specific conductivity of the solution is 0.1400 to 0.0900 at 37° C. and the pH is 0.12 to 0.60-0.70.

The importance of the thickness of anodic oxide layers is stressed by E. KAPERNICK ("Valuable and Deficient Electrically Produced Oxide Layers," *Aluminium & Non-Ferrous Rev.,* Vol. 4, June 1939, pp. 221-224). Corrosion resistance is impaired considerably by insufficient thickness, especially if there is simultaneous abrasion. A layer of 2-3 μ is not enough in this case. The oxide layer on alloys that are subject to aging (*e.g.* with Cu) is considerably softer than on pure Al. On homogeneous Al-Mg-Si and Al-Mg alloys a uniform layer is formed. For parts subject to ordinary atmospheric conditions a thickness of 3 μ is required, but if the part is subject also to mechanical wear, 6 μ minimum thickness of oxide film should be applied. For exposure to salty atmospheres or active gases, and if strong wear is expected, the coat should be 10 μ or more.

While the original coloring agents for anodic oxide coatings were largely organic in nature, there has been some application of mineral coloring materials. A new inorganic pigmenting process, called the "Ematol" process, is described by E HERRMANN ("The Ematol Process for Anodic Oxidation," *Light Metals,* Vol. 2, Sept. 1939, pp. 324-325). The pigment is produced directly from salts such as those of Ti, Zr, Th, which are dissolved in the electrolyte. The salts are decomposed to insoluble opaque hydroxy-compounds which are anchored in the coating. The striking appearance of an "Ematalized" article is its ceramic-like opacity. These coatings are highly inert chemically, and do not appear to undergo any change during the course of normal use. X (7a)

The Protection of Silver by the Electrolytic Deposition of Beryllia. L. E. PRICE & G. J. THOMAS. *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 844, 8 pp. Original research. In a previous paper it was shown that the tarnishing of Ag and Ag alloys could be greatly diminished by the deposition on their surface of a thin invisible film of hydrated beryllia or alumina by an electrolytic method. The conditions necessary for the production of highly tarnish-resistant films from a solution of $BeSO_4$ were investigated. The pH of the solution must be between the pH corresponding to the formation of the basic sulphate $BeSO_4 . Be(OH)_2$ and the pH for the complete precipitation of the hydroxide. Observations of the cathode potential during the deposition showed that it is possible to follow the formation of the film of beryllia. Protective films on Ag were also obtained by cathodic treatment in solutions of $Be(NO_3)_2$, $BeCl_2$, $AlCl_3$, and $Al_2(SO_4)_3$. JLG (7a)

7b. Non-Electrolytic Methods

Coating Metals with Rubber-like Compounds. The dizzy pace maintained by the organic chemical industry in the last decade in developing all kinds of industrially and popularly useful synthetic products, and finding new by-products for old uses, leaves even the metallurgical engineer somewhat breathless. Two such products "Neoprene" and "Koroseal" are reported to be excellent for protective coatings, and are therefore of more than casual interest to metal men.

F. L. YERZLEY of du Pont ("Adhesion of Neoprene to Metal," *Ind. Eng. Chem.,* Vol. 31, Aug. 1939, pp. 950-956) studied the influence of flow and pressure on the quality and strength of neoprene-to-metal adhesion. Interpretation of results is facilitated by the study of the yield point on the load-elongation curve in a type of internal failure that can be observed only by the use of relatively thin (1/8 in.) vulcanizates in the test piece. Cleanliness of the brass surfaces and proper control of trapped air and porosity are important in the adhesion of neoprene to brass. A procedure is developed for the use of chlorinated rubber as an adhesive, and it is shown that it can be applied to steel, 18-8 stainless steel, Cu and Al, and remains hard up to about 155° C.

Out of the laboratories of the Goodrich Co. came Koroseal, and F. K. SCHOENFELD, A. W. BROWNE, JR. & S. L. BROUS ("Recent Developments with Koroseal," Ibid., pp. 964-968) describe some of its applications. Koroseal, a thermoplastic requiring no vulcanization, is valuable for uses where water, acids, alkalies, oxidizing agents, and corrosive chemicals are handled. Its chemical inertness makes it suitable for covering metal tanks, pipe lines, wire cable, etc. Steel and Koroseal have been combined to give a sturdy tank that withstands both mechanical and chemical abuse. MEH (7b)

8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

The Two Yield Points of Mild Steel. The European controversy still rages over whether the existence of two yield points in mild steel is characteristic of the material, or is just the result of faulty testing conditions. G. WELTER & S. GOCKOWSKI ("Influence of the Resiliency of the Test Machine and of the Loading Speed upon the Determination of the Yield Point for Mild Steel," *Metallurgia,* Vol. 20, Aug. 1939, pp. 143-148) say there's only one yield point. Testing machines were modified so that either the normal hard loading could be used or a special soft loading. For non-hydraulic machines soft loading was obtained by using a spring in series with the specimen. With soft loading no upper yield point was obtained, and the yield point found equaled the lower yield normally obtained. The upper yield was dependent on testing speed, but the yield point in the soft machine was independent of speed.

However, E. SIEBEL & S. SCHWAIGERER ("Einfluss der Prüfbedingungen auf die Ausbildung der Streckgrenze bei weichem Flussstahl," *Arch. Eisenhüttenw.,* Vol. 13, July 1939, pp. 37-52), after an extensive series of tests, claim to have proved that the appearance of an upper and lower yield point in soft steel represents a property of the material and not merely testing conditions. Rapid loading tends to raise the yield point. Effects due to springing of the machine—soft or hard—were found, but only in types of springing outside the range of the ordinary testing machine. In the usual testing machine in a carefully made test the actual upper and lower yield points are correctly determined, say these authors. X (T-8)

Notch-Impact Testing. Sometimes it seems as though the notch-impact tests are being made to cover too much ground, and that excessively blind reliance is often placed on their results as criteria of general quality. Nevertheless, the legitimate uses of the tests are growing, and there is no doubt that few engineering tests can be as useful in appraising material for certain specific services. Three recent articles have discussed notch-impact testing for determining the work-brittleness of steel, the low-temperature toughness of steel, and the quality of welded joints.

Various tests may be used to measure the effect of cold work on the hardness and brittleness of steel, but most of them are slow and laborious. A simple test is described by H. W. GRAHAM & H. K. WORK ("A Work-brittleness Test for Steel," *Am. Soc. Testing Materials,* Preprint, June 1939, 10 pp.), which consists essentially of drawing a tapered specimen through a die, notching it at points representing various increments of cold work, and breaking it in an Izod impact machine. A 10-in. specimen tapered from 0.450 to 0.475 in. is used, which gives a range of cold working, measured as reduction of area, from zero to about 10.6%. This is then notched with the standard Izod V-notch at 1.1-in.

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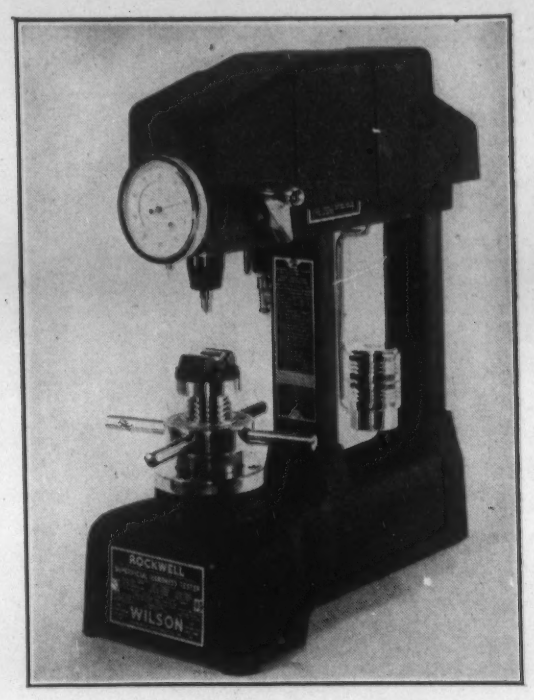

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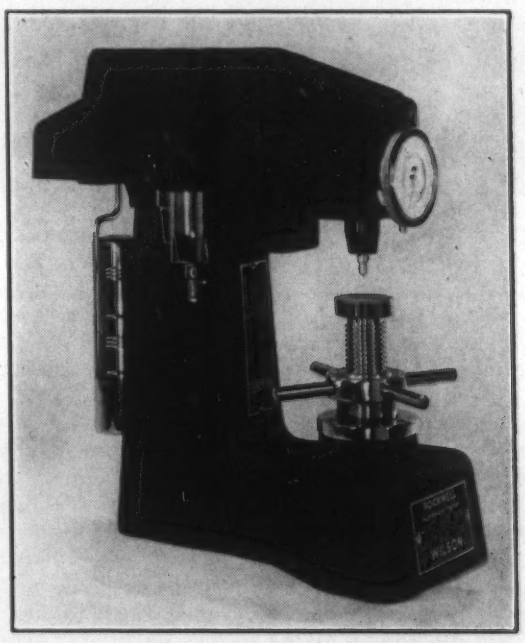

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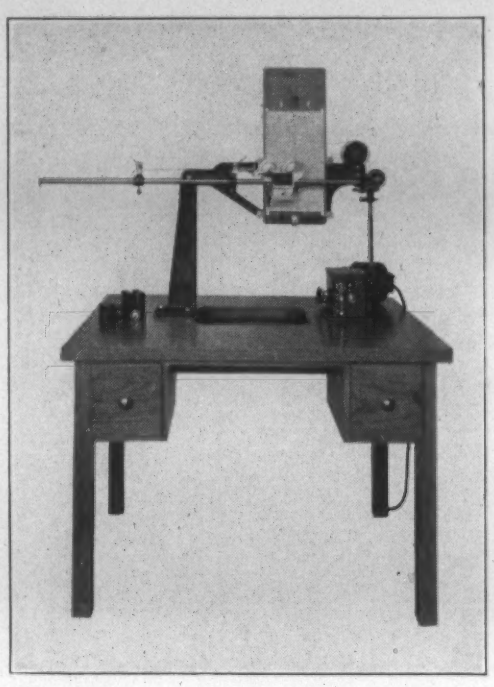

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intervals along its length. The Izod impact in % of unstressed value is plotted against % reduction of area, to give a curve which is characteristic of a given heat of steel. This test was devised for homogeneous steels; that is to say, those fully killed or deoxidized. For rimmed steels it measures the sensitivity of substantially the core portion only of the ingot. The sensitivity characteristic of a steel, which is determined by the work-brittleness test, has been found to be related to numerous other physical properties, including fatigue, machinability, hardenability and susceptibility to toughness-improvement by annealing; higher values of these properties are found in the more "sensitive" steels.

The effect of testing conditions, for both Charpy and Izod tests, on notch-impact testing results at sub-zero temperatures was studied by W. Crafts & J. J. Egan ("Factors Affecting Notched-bar Impact Tests on Steel at Low Temperatures," *Am. Soc. Testing Materials*, Preprint, June 1939, 13 pp.). Tests at low temperatures (room, —50° and —78° C.) of bot hIzod and Charpy types were made on a machine in which the initial energy and velocity of blow could be varied independently. In both Charpy and Izod types the machines of different manufacturers can be calibrated or the data adjusted to give comparable values. The simple beam (Charpy) results are affected by the initial energy and velocity so that correction of the results would be necessary for comparison of the data from machines in which these factors differ. The results are relatively insensitive to depth of notch, and the radius of the standard specimen is large enough to facilitate accurate machining. Comparable results between different Charpy machines, therefore, depend primarily on the original design rather than on maintenance in good condition and accurate specimen preparation. The cantilever beam (Izod) results are unaffected by initial energy and velocity but are influenced strongly by length of the cantilever arm. The results are also relatively sensitive to notch depth and radius. The accuracy of the Izod type machine appears to depend less on original design and more on careful maintenance of machine dimensions and on accurate specimen preparation.

General agreement may be anticipated between different machines of the same type but imposition of an arbitrary minimum impact strength in specifications is not justified unless the testing temperature and minimum value are not severe or unless the conditions of the test are defined in much more detail than is customary at present. Velocity as such has little if any effect on the results as long as the notch is sufficiently deep and sharp, and the specimen of such a size that stress concentration can be realized. The notched-bar impact test is a suitable criterion for estimating the resistance to brittle failure of unnotched sections under static load.

The applicability of notched bar testing to the evaluation of multiple-layer weld-quality in mild steel is demonstrated by K. L. Zeyen ("Versuche mit Prüfverfahren zur Ermittelung der Verformungsfähigkeit von Mehrlagenschweissungen an weichem Flussstahl," *Tech. Mitt. Krupp*, Vol. 7, July 1939, pp. 96-120). The welds were made by gas or electrical methods, and the notch was cut in the weld, in each case. Some of the tests were made at temperatures down to —70° C. and others up to 400° C. A relation could be established between elongation and notch-toughness, but not between bend test results and notch impact strength. Among the factors affecting the quality of the weld, as revealed by impact tests, the chemical composition of the weld metal—and particularly its nitrogen and oxygen content—was predominant. The detrimental effects of N and O on notch toughness could be partially corrected by annealing some samples (*e.g.* gas-welded, non-austenitic steels) but not so with others (*e.g.* electrically welded, high-N non-austenitic welds). Austenitic joints usually gave better results, as regards notch-impact strength, than non-austenitic. Among the austenitic materials, 25 Cr, 20 Ni rod gave better weld toughness than 18 Cr, 8 Ni. X (T-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

The Appearance of the Fatigue Fracture (Das Gesicht des Dauerbruchs) M. Ehrt & G. Kühnelt. *Materialprüfungsstelle der Allianz u. Stuttgarter Verein Vers. A.-G., Abteilung für Maschinenversicherung,* Report No. 4, Nov. 1938, 51 pp. Research survey. This is an interesting and highly useful collection —[an astonishing accomplishment for an insurance company—G. N.]—of 118 different fatigue fractures, illustrated and described at length, considering the principles underlying the different types and emphasizing the particular characteristics. After a brief outline of the origin and formation, basic types of fatigue fractures under different types of loading are considered as tensile fatigue fractures, fatigue fractures due to one-sided, double-sided and rotating load application and those due to bending and torsion. 5 references. GN (8a)

Fatigue Strength of Machined Forgings 6 to 7 Inches in Diameter. O. J. Horger & H. R. Neifert (Timken Roller Bearing Co. *Preprint, Am. Soc. Testing Materials,* June 1939. Original research. In view of the unreliability of using results of fatigue tests of small polished specimens as a direct basis for computing the strength of large shafts and axles under repeated stress the Association of American Railroads is conducting fatigue tests on full-size passenger car axles. The testing machines used are large rotating-beam machines of the cantilever type capable of testing full-size axles at a speed of 1500 r.p.m. Testing machines for specimens 1½ in. diam. and for specimens 0.3 in. diameter were also used. The material was a 0.40% C A. A. R. Specifications for axles M-101-36, grade B. The test results given constitute a progress report on the fatigue strength of the body section of railroad car axles. While exceptionally few fatigue failures occur in actual railroad service in the plain body sections of car axles, when pressed or clamped-on members are not applied, it is important to note that these tests developed an endurance limit of 17,500 lb./in.^{2} for the full-size axle as compared with 33,000 lb./in.^{2} for polished specimens 0.3 in. in diam. Profilograph records of axle surface and micrographs of crystalline structure of metal are given. HFM (8a)

Fatigue Strength of Hard-chromium-plated Parts (Dauerfestigkeit hartverchromter Teile) H. Wiegand & R. Scheinost. *Z. Ver. deut. Ing.,* Vol. 83, May 27, 1939, pp. 655-659. Research. The effect of a Cr deposit of varying thickness on steel tools was investigated by bending fatigue tests. Although the advantages of the hard Cr-deposit as regards surface protection and wear resistance are well known, the H occluded from the hard-Cr-plating bath might impair the mechanical properties of some steels that absorb atomic H easily. The experiments show clearly a reduction of bending fatigue strength of the Cr-plated pieces of from 5 to 31%, according to the plating process; this reduction, which must be ascribed mainly to atomic H absorbed in plating, was greater for thicker deposits. The deposits often show very fine fissures. Parts subject to alternate stresses, and also parts working at temperatures over 100° C., should not be hard-Cr-plated, especially if local stress concentration through notches or otherwise is to be expected in the part. Ha (8a)

9 Metallography

Structure and Constitution. Metallographic Equipment.

J. S. MARSH and C. S. BARRETT,
SECTION EDITORS

Processes for the Production of Metallic Single Crystals (Die Verfahren zur Herstellung von Metall-Einkristallen) H. SCHOENECK & H. VERLEGER. *Metallwirtschaft,* Vol. 18, June 30, 1939, pp. 576-584. Review. Single crystals can be formed from solids, liquids or gases. Single crystals have been made from solid metals by recrystalliztaion, slight but critical deformation of the metal plus appealing for long times at increasing temperatures. Single crystals of Al, Mg and Fe, as well as of Al-Zn and Al-Cu alloys have been made by the methods. Crystals of Cu made by this method contains twins and therefore cannot be classified as single crystals. Large single crystals can also be made from the solid state by coalescense; an example is the production of large crystals in tungsten wires containing a small amount of thoria.

Numerous methods are available for forming single crystals from the liquid state. The methods can be divided into those which the specimen is formed in a suitable melting container through slow freezing, and those which the specimens are drawn from the melt as small rods. By using a seed crystal in many of these processes it is possible to obtain crystals with a certain desired orientation. Single crystals can also be produced by electrolysis. By using a seed crystal of tungsten as a cathode and surrounding it with an anode of tungsten it is possible to increase the size of the seed crystal. A process of similar nature has been used for producing single crystals from the vapor state by decomposing WCl_6 with hydrogen and allowing the resulting tungsten vapor to deposit on a seed crystal. Single crystals can, however, be made from the vapor state without the use of seed crystals. By subjecting a melt to compressed air and producing fine metal droplets it is possible to get single crystals of a magnitude 20—.2μ in diameter. 80 references. GA (9)

9a. Ferrous

The Structure of Cast Steel in Relation to the Rate of Cooling. J. A. VERÖ. *Iron Steel Inst., Carnegie Schol. Mem.,* Vol. 27, 1938, pp. 165-192. Research. The structures and mechanical properties (compressive yield point, impact strength and hardness) of common acid steel castings, with carbon contents from 0.12 to 0.58% and cross sections varying from 10 x 150 mm. to 150 x 150 mm., were studied in the cast and heat-treated states. Three zones were observed in the primary structure, a fine grained rim, a region of columnar dendrites and another of equiaxed dendrites. With increase of melting temperature (for material of the same carbon content) the structure tended to be more globular, indicating a probable redistribution of particles (acting subsequently as nuclei) as the melting temperature is changed. The size of the primary crystals in the innermost zone is increased with decreased cooling rate. The depth of the columnar zone decreased with increased pouring temperature. It is experimentally shown that phosphorus causes carbon to migrate toward the center of the austenite crystals. As the cross sectional area is increased (rate of cooling decreased) Widmanstätten and laminated structures are formed in alloys of a greater carbon range. The dendritic and the much smaller globular crystals across a section of the same specimen are remarkably similar with respect to secondary crystallization. The mechanical properties are variable; the character of the primary structure whether globular or dendritic, exerts no appreciable effect, although the known effect of the size of the primary crystals appears very clearly. 35 references. CW (9a)

Heat Etching as a Means of Revealing Austenite Grain Size. M. J. DAY & J. B. AUSTIN (U. S. Steel Corp.) *Preprint, Am. Soc. Metals,* Oct. 1939, 15 pp. Research. Heat etching that causes preferential removal of material from the grain boundaries was studied as a method of revealing austenite grain size. A simple technique has been developed which has been used successfully with purified iron, hypoeutectoid steels, hypereutectoid steels and high alloy steels over a wide range of heat treating conditions. The method consists of holding a polished specimen in an inert atmosphere at the desired temperature for the desired time and then quenching it in mercury, which procedure marks unambiguously the austenite boundaries at the time of quench.

The method is described as the only practical non-carburizing method available today for delineating the austenite grain boundaries of steels with less than 0.1% carbon; it yields identical results with other non-carburizing methods where comparison is possible. The decarburizing action of carefully purified hydrogen was found to be so slight as to leave the carbon content of the specimen substantially unaltered. The usefulness of the method with low-C steel is demonstrated by a study of grain growth in an Al-killed steel containing 0.07% C over the temperature range 1700°-2500° F. The results show that for this steel the term "coarsening temperature" is not precise unless the time at temperature is specified. (9a)

A Magnetic Study of the Iron-nickel-aluminium System. W. SUCKSMITH. *Proc. Roy. Soc., (London)* [*A*], Vol. 171, July 1939, pp. 525-540. Original research. Measurements were made of the saturation intensity in strong magnetic fields of slowly cooled and quenched samples of over 80 alloys in the Fe-Ni-Al system. The specimens, which had previously been examined by X-ray methods by Bradley and Taylor *(Proc. Roy. Soc.,* [*A*], Vol. 166, 1938, p. 353), were heated to 900° C. and either slowly cooled *in vacuo* at 10° C./hr. or quenched in cold water. In addition, the temperatures at which the alloys changed from the ferro-magnetic to the para-magnetic state were observed. Each phase region was found to show characteristic features, and in most instances phase changes could be related to the variations of the saturation intensity. In the α field, the superlattice is more magnetic than the disordered material. The relation between ordered and disordered lattices in other regions of the phase diagram is discussed in detail. JCC (9a)

Niobium-iron Alloys. R. GENDERS & R. HARRISON. *J. Iron Steel Inst.,* Adv. Copy No. 2, Sept. 1939, 9 pp. Original research. The diagram and some of the properties of Fe-rich Fe-Cb alloys were investigated. The compound Fe_3Cb_2 is formed. The solubility of Cb in α Fe is very small at room temperatures and about 1.8% at the peritectoid temperature. Cb increases the hardness of Fe, and makes possible precipitation hardening. Cb is not used in simple steels, but it is used for prevention of weld decay in Ni-Cr stainless steels. Work on the subject of Cb in nitriding steels will be published shortly. JLG (9a)

9b. Non-Ferrous

The Aluminum-copper-antimony System. M. I. ZAMOTORIN & L. N. SOLOV'EVA. *Metallurg,* Vol. 14, July 1939, pp. 11-16. In Russian. Research. Alloys containing Al-Cu-Sb were prepared from Al (0.11% Si, 0.37% Fe), electrolytic Cu (99.97% Cu), and Sb (99.50% Sb). A Kurnakov pyrometer was used to record the cooling curves lying in the section $CuAl_2$. AlSb, in sections having a constant ratio of Cu/Sb, and in sections having a constant content of Sb. The Al-$CuAl_2$-AlSb diagram shows three areas of primary crystallization. A greater part of the diagram is occupied by the area of primary separations of crystals of the composition AlSb. Primary crystals of α-solid solution and $CuAl_2$ are separated out only in a small region of the ternary diagram. Al forms with $CuAl_2$ and AlSb a eutectic diagram having a limited solubility in the solid state. The ternary eutectic of the composition 1.50% Sb, 34.15% Cu, and 64.35% Al crystallizes at 545° C. BZK (9b)

The Transformations in the Copper-palladium Alloys. F. W. JONES & C. SYKES (Metropolital Vickers Electrical Co.) *J. Inst. Metals,* Vol. 65, 1939, *(Adv. Copy)* No. 842, 15 pp. Original research. The equilibrium diagram of the Cu-Pd alloys was determined from X-ray photographs of slowly cooled alloys used in conjunction with the resistance measurements of Taylor. The transformation in the alloy Cu_3Pd was examined by means of resistance measurements, X-rays, and specific-heat measurements. Very slowly-cooled Cu_3Pd has a complicated tetragonal structure. Resistance measurements indicate that anti-phase nuclei such as are found in Cu_3Au may be present in rapidly cooled alloys containing up to 18% Pd. JLG (9b)

10 Properties and Applications

Including Relation of Properties to Engineering or Product Design. See also Section 8a and 11.

M. GENSAMER, A. J. PHILLIPS and H. C. CROSS,

SECTION EDITORS

The Friction of Clean Metals and the Influence of Adsorbed Gases. The Temperature Coefficient of Friction. F. P. BOWDEN & T. P. HUGHES. *Proc. Roy. Soc. (London)* [*A*], Vol. 172, Aug. 1939, pp. 263-279. Original research. The friction between a small cylinder projected along a rod by a spring was determined by recording its motion photographically. The equipment was mounted in a tube, which could be evacuated. Tests were made with Ni sliding on W, Ni on Ni, Cu on Cu, and Au on Au. The kinetic friction was increased by as much as 20 times when the metals were thoroughly cleaned and degassed by heating *in vacuo*. The addition of a trace of oxygen caused an immediate reduction in friction with all metals, but hydrogen and nitrogen had no effect. Using clean metals, determinations were made of the temperature coefficient of friction. The effect was small, and easily masked by changes in composition of a surface film unless the metals were completely degassed. There was a small but regular decrease in friction with rise of temperature, of the order of a few % per 100° C. rise. With Au, a sudden high increase in friction occurred at 600° C., probably due to excessive softening and welding of the metal. JCC (10)

10a. Ferrous

The Effect of Small Copper Contents on the Mechanical Properties of Low-alloy Structural Steels, in particular of St 52 (Ueber die Wirkung geringer Kupfergehalte auf die Festigkeitseigenschaften von niedriglegierten Baustählen, insbesondere von St 52) E. HOUDREMONT, H. BENNEK & H. NEUMEISTER. *Tech. Mitt. Krupp,* Vol. 2, Aug. 1939, pp. 99-114. Review plus research. Copper contents up to 0.5% are without appreciable effect on mechanical strength of pure Fe and soft carbon steel if they are cooled so slowly (in air or furnace) that no structural hardening takes place. Copper, however, increases the hardenability, and therefore makes its influence felt at high cooling velocities. Steels of higher strength show, even with a few tenths of 1% Cu, a 1-3 kg./mm.^{2} higher elastic limit and tensile strength. Tests corroborated this result, giving 1-4 kg./mm.^{2} increase for elastic limit and a maximum of 2 kg./mm.^{2} for tensile strength. Mn-Cr steels failed to show this effect so clearly. For steels to be welded, Cu is advantageous because, like Mn, it increases hardenability, but not absolute hardness. Additions of less than 0.5% Cu incur no danger of brittleness near the welded seam. Ha (10a)

The Effect of Vanadium and Chromium in High Speed Steels in Which Alloying Elements Are Low for Economy (Untersuchungen über die Wirkung des Vanadin-und Chromgehaltes bei sparstoffarmen Schnellarbeitsstählen) R. FIZIA, K. GEBHARD, F. RAPATZ, & R. SCHERER. *Stahl u. Eisen,* Vol. 59, Aug. 31, 1939, pp. 985-990. Review. In low-alloy high speed steels the V content may advantageously be raised to 2.5 to 3% in order to save on W and Mo. More V than this, however, in the same type of steel is of no benefit. The C must, of course, be raised as the V content is increased. No serviceable high speed steel can be made with Cr as the sole alloying element. Indeed it appears doubtful that raising the Cr content above the customary 4% in W and Mo high speed steels is of any benefit or can effect a saving in Mo or W. SE (10a)

10b. Non-Ferrous

Magnesium Alloy Die Castings. The production of Mg alloy die castings is still small, compared with that of Al- and Zn-base die castings, but applications are rapidly increasing as die-casters and design engineers become more familiar with the advantages and limitations of Mg alloys in this form. American practice in making and treating Mg die castings, their properties and general uses, and their specific applicability in the automotive industry are reviewed in 3 recent articles.

According to HERBERT CHASE ("American Practice in Die Casting Magnesium Alloys," *Light Metals,* Vol. 2, Sept. 1939, pp. 320-321), certain producers are offering Mg die castings at the same price per casting as Al castings, a condition that presages an expansion in use of the lighter metal die castings. The so-called cold chamber, or high pressure process, produces castings that are denser, stronger, and with better surface finish than the air injection castings. The high pressure machine operates at about 4,000 lbs./in.^{2} Mg alloys contain 6-10% Al and 0.10-0.15% Mn, but up to 0.6% Zn or 0.5% Si may be added to increase fluidity. [Most castings are made from A.S.T.M. alloy No. 13, containing 9% Al, 0.6% Zn, 0.13% Mn, according to A. W. WINSTON ("Magnesium Alloy Die Castings," *Am. Soc. Testing Materials, Preprint,* June 1939).] Chase gives tensile strength as about 28,000 lbs./in.^{2}, with yield strength (at 0.2% set) of 18,000 lbs./in.^{2}, and elongation in 2 in. of 1-4%. For A.S.T.M. alloy No. 13, Winston gives somewhat higher values (33,000 tensile, 21,000 yield, 3% elongation; also Brinell hardness of 60 and Izod value of 2 ft.-lbs.). Chase points out further that surface quality does not vary much within the prescribed composition limits. Tests have shown that nothing is gained by increasing the die casting pressure above 4,000 lbs./in.^{2} The mechanical properties can be altered somewhat by solution treatment and aging. Most of the alloys may be made more ductile by solution treatment, but at the expense of the yield strength. Mg die castings are very stable under ordinary exposure if free ventilation and adequate moisture drainage be provided. Under conditions of high humidity a surface roughening with the formation of an oxide or hydroxide film is noted. Treatment in caustic soda at high temperature and pressure is said to form an adherent film which resists steam and marine atmospheres very well. Die castings resist salt water corrosion better than sand castings and wrought alloys of the same composition.

Winston *(loc. cit.)* states that die castings more than 200 in.^{2} in projected area and up to 74 in. long have been made of Mg alloys. The usual die casting tolerances may be applied for Mg alloys. Surface treatments described by him include the chrome-pickle treatment in a solution of nitric acid and sodium dichromate and a paint system for decorative effect. The widening field of applications of Mg alloy die castings include engine and instrument parts in the aircraft industry, automobile starting motor and generator parts, vacuum cleaners, motion picture cameras, binocular frames and portable tools. Typewriters, business machines, textile machines and other automatic machinery also use Mg alloy die castings.

Automotive applications of Mg alloy die castings in Germany are discussed by A. BAUER ("Entwicklung und heutiger Stand der Verwendung von Magnesiumspritzgussteilen in der Kraftfahrzeugindustrie," *Automobiltech. Z.,* Vol. 42, June 25, 1939, pp. 334-337). Mg is almost as easily machinable as wood, only very small machining allowances (0.3 to 0.5 mm.) being required. In comparison with Al, the only disadvantage is lower corrosion resistance, which can, however, be overcome by surface treatment and lacquering. Oil pump housings are widely made from Mg die castings, Mg also forming the bearings for axles and gears. Bushings are necessary only under very difficult conditions. The use of Mg as bearing metal depends upon the employment of force-feed lubrication, hardened (60 Rockwell C) carefully ground shafts, and moderate bearing pressures. Cam shaft bearings are made from Mg die castings, as are housing covers for gear drive, etc. For such covers, only a small amount of subsequent machining is necessary, the holes being cast in; the base surface is simply smoothed a little with emery. The wall thickness can be 3-3.8 mm., as compared with 4-5 mm. of cast iron. New applications were created by the compound-casting, *i.e.* incorporating steel parts in the Mg die casting. Belt pulleys are made this way: The belt groove is formed of steel sheet, and Mg is pressed around it at 1,500 lbs./in.^{2} pressure. The shrinking forces help to bond the two metals tightly together, and no machining or counter balancing is necessary. Because no counter balancing is required, Mg fan blades are made economically, and the blade cross section can be selected according to aerodynamic principles, instead of being limited by the gage of sheet metal employed. X (10b)

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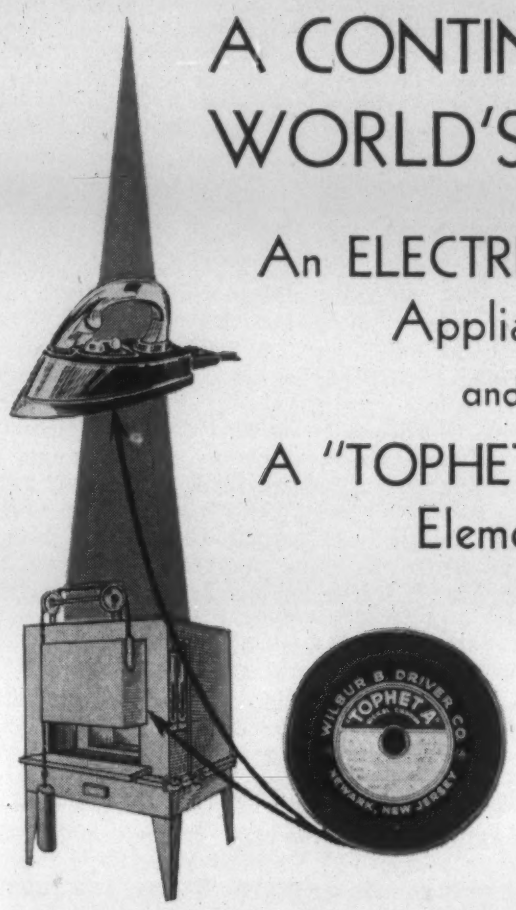

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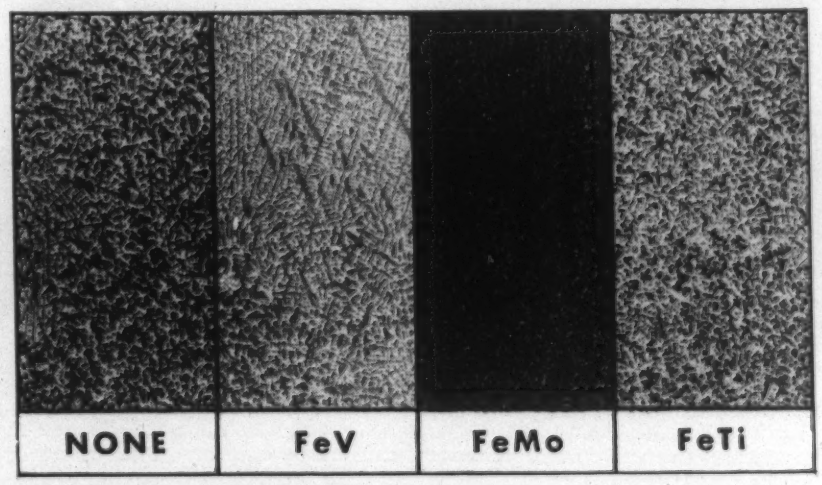

The macrographs above [from a report of the Research Inst. of the Skoda Works, Pilsen, presented as an exchange paper from the Czech. Tech. Foundry Ass'n, Sept. 1935] show the effects of different alloy additions on test ingots of .40 carbon steel made under identical conditions.

Of principal interest is the varying character of the dendritic crystals and the fact that each steel shows a well developed dendritic structure, except for the one treated with Ti where the dendrites are short, mostly nodules. This is the result of the influence of Titanium on primary crystallization which alters the mode of solidification, producing a larger number of centers of crystallization and a finer grain throughout the ingot.

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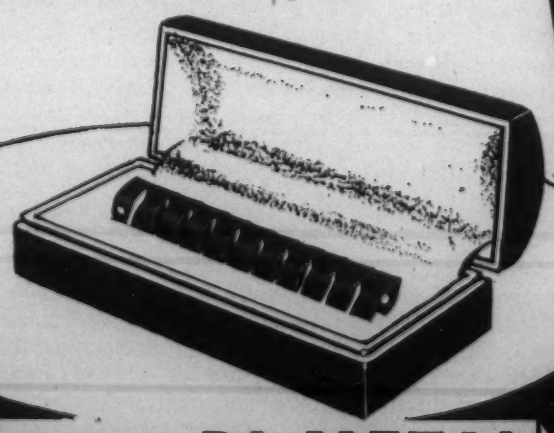

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10c. Effect of Temperature

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Impart Properties of Alloy Steels at Sub-zero Temperatures. Two recent articles, one concerned chiefly with Ni steels in the commercial low-temperature range, and the other with various alloy steels down to sub-sub-polar temperatures, emphasize the usefulness of the notch-impact test as an evaluation of serviceability of steels for use in cold climates, high altitudes, refrigeration equipment, etc. For applications involving temperatures down to —75° F., there are several steels, both wrought and cast, that resist low-temperature embrittlement sufficiently to perform satisfactorily. For lower temperatures, austenitic stainless steels and non-ferrous metals have been employed, but with the increased use of processes involving temperatures lower than —100° F., there has been a search for less expensive materials.

T. N. Armstrong & A. P. Gagnebin ("Impact Properties of Some Low Alloy Nickel Steels at Temperatures Down to —200° F.," *Preprint, Am. Soc. Metals,* Oct. 1939, 20 pp.) give results of their tests on Ni steels. Specimens of several normalized and drawn Ni and Ni-Mo steels, produced both experimentally and commercially, were machined from rolled bars, from cast coupons and from deposited weld metal and tested in impact (Charpy specimens with keyhole notch) at temperatures down to —200° F. The following steels showed good impact values within this temperature range: (1) Properly deoxidized, normalized and drawn cast steel containing 0.15% C max. and from 3.5 to 4% Ni; and cast steels containing 0.15% C max., 2.75% Ni and approximately 0.30% Mo. (2) Normalized and drawn wrought steels containing 0.17% C max. and a minimum of 2.75% Ni. Optimum Ni content in the plain nickel steels appears to be between 3.50 and 4%. (3) Normalized and drawn wrought steels, containing low C and substantial quantities of Ni and Mo, that have been deoxidized with Al. (4) Any of the above wrought steels after liquid quenching and drawing and, in addition, higher C, fine-grained Ni, Ni-Mo, and other Ni alloy steels that have been quenched and drawn.

Provided the soundness of welds can be assured by some non-destructive method, such as radiographic inspection, welds made with heavily coated, low C, 2.5% Ni, 0.20% Mo steel electrodes will meet most requirements for impact resistance at temperatures down to —150° F. It is probable that welds made with other steels will maintain good impact resistance at temperatures down to —100° F. and slightly below, but it is believed that there are few steels that will give weld deposits possessing the combination of tensile properties and low temperature impact resistance secured with this Ni-Mo steel.

In an extensive study of notch-impact toughness of a variety of alloy steels at temperatures from +20° C. down to —253° C., the boiling point of hydrogen, A. Pomp, A. Krisch & G. Haupt ("Kerbschlagzähigkeit legierter Stähle bei Temperaturen von +20 bis —253°," *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch. Düsseldorf,* Vol. 21, No. 15, 1939, pp. 219-230) find the austenitic steels definitely superior to the low-alloy steels. However, the superiority is so much more marked at the extremely low temperatures than at temperatures down to —150° C. that the likelihood of the more expensive austenitic materials predominating in applications at temperatures within the moderately low range is small; at extremely low temperatures they appear in some respects to be almost indispensable. Forty different materials—low-alloy steels of various types; austenitic Ni-, Cr-Ni, and Cr-Mn steels; soft iron; nickel; copper; lead; etc.—were investigated. The austenitic steels at —253° C. had impact values as high as 22 kg.-m., whereas the values for other steels were sometimes as low as 2 kg. m. at that temperature. X (10c)

Creep Testing by Determining Time-loading Curves (Dauerstandversuche unter Aufnahme von Zeit-Spannungs-Kurven) K. Wellinger. *Arch. Eisenhüttenw.,* Vol. 12, May 1939, pp. 543-550. Original research. A creep testing machine is described in which the creep characteristics of a steel are determined by the falling off in load as the specimen is kept at a constant temperature and stretched at a constant rate of extension. The time to give a total extension of 0.5% and a fall in load at a rate of extension of 1.10^{-4}%/hr. is used as a basis of comparison. This time was relatively short for various alloy steels studied; besides, the data are obtained after only 1 test, whereas in the usual way of determining stress-extension curves, 3 or more tests are required. The results were comparable to those obtained by former methods. SE (10c)

11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation, Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

Rate of Oxidation of Steels as Determined from Interference Colors of Oxide Films. DUNLAP J. MCADAM, JR., & GLENN W. GEIL. *J. Research, Natl. Bur. of Standards,* Vol. 23, July 1939, pp. 63-124. Original research. By use of interference colors, investigation was made of the variation of thickness of the oxide film on steels with temperature and time. The rate of oxidation varies as a high power of the absolute temperature. If, over short intervals, the oxidation time at constant temperature is assumed to vary as a power of the film thickness, the exponent decreases from 100 or more for thin films to about 2 for thick films. The film thickness, for constant oxidation time, increases rapidly with the absolute temperature. If, over short intervals, the thickness is assumed to vary as a power of the absolute temperature, the exponent increases with increase in film thickness, from 1 or less to about 20 or 25. The accelerating influence of temperature thus predominates over the retarding influence of increase in film thickness. Iron and carbon steels, alloy tool steels and Ni steels, Cr steels, and Cr-Si and Cr-Ni steels were compared with reference to resistance to oxidation. The influence of alloying elements is discussed. WAT (11)

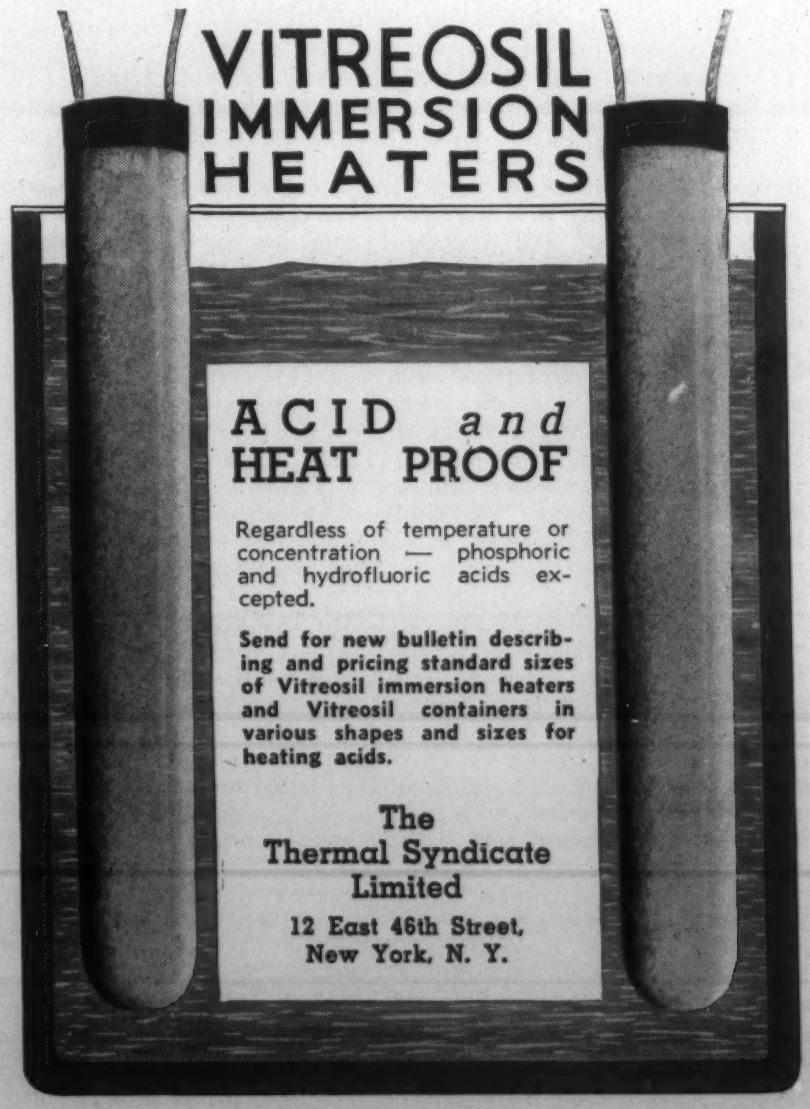
Stress Corrosion Cracking of the Austenitic Chromium-nickel Steels and Its Industrial Implications. JAMES C. HODGE & JOHN L. MILLER. *Preprint, Am. Soc. Metals,* Oct. 1939, 43 pp. Investigation of service failures. A number of service failures of the austenitic 18/8 Cr-Ni steels have occurred as a result of the formation of localized cracks. Service conditions had not involved repeated or variable stressing and had not necessarily involved materials susceptible to intergranular corrosion. Review of several cases indicated that the failures had involved a condition of internal static stress and exposure of the stressed material to certain corrosive media, which in some cases were so inactive that they left ordinary carbon steel unaffected. In the present paper, two specific service failures were studied: (1) Thermowells containing ethyl chloride used to permit temperature control in sulphite paper digesting, and (2) boiler superheater tubes.

The failures were identified as bein gof the stress corrosion type and closely allied to the "season cracking" of certain brasses and to the stress corrosion cracking exhibited less frequently in other metals, as for example the caustic embrittlement of boiler plate. Such stress corrosion cracking may occur in austenitic steel independent of its condition with respect to susceptibility to intergranular corrosion. The tendency to failure is, however, more pronounced when the material is in such condition that intercrystalline corrosion can develop. The path of stress corrosion cracks in these alloy steels may be intercrystalline or transcrystalline, dependent upon the corrosive medium, the stress magnitude and the degree of susceptibility of the material to intergranular corrosion. The cases of transcrystalline cracking of austenitic Cr-Ni steels which have been noted are exceptional since other known cases of stress corrosion or "season cracking" of other metals are invariably intercrystalline.

Of many corrosive agents investigated, a mixture of ethyl chloride and water was found to be very effective in producing stress corrosion failure. Ferric chloride and mercuric chloride solutions were also found to have a very damaging effect. In both service failures and in experimental tests even mildly corrosive agents, which would leave plain carbon steel unaffected, were capable of producing stress corrosion cracking. Tendency to stress corrosion cracking increases with increasing stress. Highly stressed conditions may be readily introduced by certain fabricating operations such as cold bending, welding or rapid cooling from elevated temperatures, and also by the use of composite structures, such as a welded attachment between austenitic and ferritic steels.

Elimination of the possibility of stress corrosion cracking can be secured only by removal of fabricating stresses with annealing treatments utilizing slow rate of cooling. This requires the use of stabilized alloys containing Cb or Ti to avoid the possibility of intergranular corrosion. Design of structure and thermal operation of structure in service should be such as to eliminate the introduction of high service stresses. If high service stresses should be introduced, there is no assurance that annealed structures of stabilized alloys will not fail under certain types of corrosive conditions, the field of which has not as yet been completely explored. (11)

The Formation of Hydrogen Peroxide During Corrosion Reactions. J. R. CHURCHILL (Aluminum Res. Labs.) *Trans. Electrochem. Soc.,* Vol. 76, 1939; Preprint No. 7, 15 pp. Original research. When many materials are placed near a photographic plate in the dark, a black image of the object is obtained. This is known as the Russell effect and was believed caused by the production of hydrogen peroxide by the object. The author verified this effect by placing small sheets of metal at a distance of several thousandths of an inch from a photographic plate. An exposure of 18 hrs. was used. Metals, which had been exposed to the air for some time prior to the test and were already covered with an oxide film, did not show the effect. Freshly abraded surfaces of Zn, Sn, Cd, Mg, Al, and Al alloys produced a strong image, but Pb, Cu, brass, Fe and stainless steel did not give an effect. On standing a number of days the metals produced weaker images. Anodized Al gave no image, but if the surface were scratched an image of the scratch was obtained. The passage of an air current between the metal sheet and the photographic plate distorted the image. Air blown through a column of fresh Al turnings affected a photographic plate. An Al surface exposed to the air adsorbed enough moisture to produce an image even when placed in an atmosphere of dry commercial nitrogen. The H_2O_2 produced when Al wire was placed in an aerated solution



was determined colorimetrically with titanium salts. H_2O_2 was formed in distilled water, and in solutions of H_2SO_4, K_2SO_4 and KCl. The H_2O_2 was shown to be produced by cathodic reduction of atmospheric oxygen. Two Al electrodes were placed in separate compartments in an aerated 1.0 *N* H_2SO_4 solution, and a small electric current passed. The amount of H_2O_2 formed in the cathodic compartment increased and the amount formed in the anode compartment approached zero as the current increased.

AB (11)

12 General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

E. F. CONE, SECTION EDITOR

Pure Iron Powder. A. H. ALLEN (Staff) *Steel,* Vol. 104, Apr. 10, 1939, pp. 43-54. Extensive review of the production, processing, and use of powdered sponge Fe. Need for sponge Fe first arose from demand for a fine precipitant for Cu from $CuSO_4$ solution in treatment of mixed oxide-sulphide Cu ores. Beginning more than 20 yrs. ago various types of furnaces have been built for low-temperature reduction of Fe oxides. These include (1) by-product coke-oven type; (2) cylindrical rotary-kiln type; (3) cylindrical steel tube, with internal transport screw; (4) various resistance-type electric furnaces; and (5) rotary-hearth muffle furnaces with (a) circular hearth, heated with fuel burned in silicon carbide tubes, (b) annular hearth, heated with fuel burned in silicon carbide tubes, (c) circular hearth, heated with fuel burned above a silicon carbide tile arch sprung over the rotary hearth, and (d) circular hearth, heated through silicon carbide tubes, and with reducing gas fed up through hearth.

The chief difficulty with type (1) was in accretions forming on oven walls and bridging across them. With type (2) 75% reduction was about the maximum attainable and accretions closed the kiln. Difficulties encountered with type (3) were lack of suitable material for retort walls and sticking of sponge to inside of tube. Type (4) proved to be too costly to operate. Small (5a) unit has been successful. In Japan, 2 (5b) furnaces were erected and were able to produce 50 tons of Fe daily when treating a beach sand containing 20-25% Fe of which 3-5% was Fe as FeO in ilmenite. However, it was impossible to obtain an end-product with more than 70% Fe, and actual costs were higher than estimated.

H. G. S. Anderson, Muskogee, Okla., has a method which is apparently commercially practicable. His (5c) furnace produces sponge Fe, reduced from mill-scale, containing 96-98% Fe. A more recent plant of his is a (5d) furnace using natural gas as both heating fuel and reducing agent, and having a daily capacity of 250-300 lbs. of sponge Fe. Using semicoke (10-15% volatile) only as reducing agent, a weight of coke equal to half the amount of Fe produced is mixed with charge. With natural gas as reducing agent, metallurgical coke or coke-breeze amounting to 5-15% of weight of ore charged is mixed with it. This coke is added to prevent sintering of charge. In a test with mill-scale finer than 35 mesh, the temperature in the furnace was 1930°-1970° F. and reduction was accomplished in about 15 min. Of major importance relative to suitability of an Fe ore for low-temperature reduction is the SiO_2 content and its intimacy of association with the Fe_2O_3. For high-purity sponge, magnetite ores or mill-scale is the best material for reduction. Other ores can be made more suitable by a "magnetic roast"; pyrites by a chloridizing roast. P, SiO_2, Cr_2O_3, and V_2O_5 are not reduced and MnO_2 is reduced to MnO at the temperatures used to reduce Fe_2O_3. C does not combine with sponge Fe during the 10-15 min. in which Fe and reducing agent are in contact in furnace. Anderson has produced successfully Ni, Co, ferro-W powder, W, Sn, Pb, Zn, and Cu from their oxides in the sponge-Fe furnace. Tests have shown commercial feasibility of producing 50-75 lbs. Fe per ft.^{2} hearth area per 24 hrs., assuming cold charge crushed to 30 mesh and comprising either 50% grade of Fe ore or mill-scale. Substantially complete reduction will be obtained if ratio of concentration of CO to CO_2 is 75 to 25% or greater; if reduction time and temperature bear their proper relationship; if there is no air leakage into muffle; and if sponge Fe is cooled to atmospheric temperature before it is discharged into air.

There is a large market for high-purity domestic sponge Fe which can be sold for about $40 per ton. Possible uses are for open-hearth, cupola, and electric-furnace charges; wrought Fe production; waterproofing ingredient in concrete aggregates; Fe $(CO)_5$ for gasoline industry; Cu precipitation and desulphurization of Pb-Zn sulphides in mining industry; and production of compressed and sintered parts such as "oilless" bearings and brake drums. The last two offer the greatest potentialities. For such parts, sponge Fe of 96% purity or better is required and must pass 250 mesh. Powder is introduced into dies of a briquetting press where shape of part is formed under 40,000 lbs./in.^{2} pressure. Dies are of special alloy steel, hardened, ground, and lapped, and will withstand 25,000 impressions before regrinding. Parts are placed in a sintering furnace for 15 min. where they are heated to 1850°-2050° F. Lower temperatures are used for higher briquetting pressures. Reducing atmosphere must be maintained in furnace. Restriking or sizing is done either while the parts are fairly hot, to reduce pressures required, or the pieces are cooled in the furnace to below 1000° F. and then transferred to sizing press. Latter is preferable if oxidation is objectionable and tolerances are small. Pressures in sizing operations are about ⅓ those used in briquetting. Compressed and sintered Fe-Powder bushings and bearings can withstand a bearing load of 50,000 lbs./in.^{2} under O velocity. Results of tests on compressed, sintered, and sized bars of 3 different types of sponge Fe show tensile strengths ranging from 23,950 to 68,300 lbs./in.^{2}; Rockwell B hardness from 60 to 82; Olsen loads from 998 to 3,978 lbs.; elongations from 2 to 12%; and reductions of area from 1.7 to 14.7%.

MS (12)

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

of Metals & Alloys, published monthly at East Stroudsburg, Pa., for October 1, 1939.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Philip H. Hubbard, who, having been duly sworn according to law, deposes and says that he is the Publishing Director of METALS & ALLOYS and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, assistant editor, and publishing director are: Publisher, Reinhold Publishing Corporation, 330 West 42nd St,. New York, N. Y.; Editor Edwin F. Cone, 330 West 42nd St., New York, N. Y.; Assistant Editor, Fred P. Peters, 330 West 42nd St., New York, N. Y.; Publishing Director, Philip H. Hubbard, 330 West 42nd St., New York, N. Y.

2. That the owner is: The Reinhold Publishing Corporation, New York, N. Y.; Ralph W. Reinhold, New York, N. Y., and L. N. Thompson, New York, N. Y., stockholders.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(signed) PHILIP H. HUBBARD,
Publishing Director.

Sworn to and subscribed before me this 28th day of September, 1939.

CURVILLE C. ROBINSON,
Notary Public
(My commission expires March 30, 1940.)

books

Cast Iron

THE ENGINEERING PROPERTIES OF GRAY CAST IRON. *By Battelle Memorial Institute. Published by Gray Iron Founders' Society, Cleveland, 1939. Paper, loose-leaf, 8½ x 11 in., 56 pages.*

The compilers of this unusually valuable volume have succeeded in collecting in convenient form the most reliable of available published data on the mechanical properties of gray cast iron. That such a volume is badly needed has been obvious to many, particularly since recent improvements in cast iron have given it ranking position as an engineering material, but to many more the comprehensive scope, yet convenient compress, of the data will come as a delightful surprise.

The book is divided into 4 sections. In the first, the most reliable data on the common mechanical properties are tabulated and size effect is extensively discussed; in the second information on machinability, corrosion resistance and other properties not easy to evaluate numerically is given; the third comprises a selected bibliography with comment on the interrelation of properties of gray iron; and the fourth consists of literature references classified according to topics.

The book is certain to be of great use to foundrymen and engineers, who are in great need of just this sort of information, but generally lack the time or the inclination to extract it from widely scattered sources in the technical literature.—FRED P. PETERS.

Furnaces

REVIEW OF MODERN FURNACE TECHNOLOGY. *By H. Etherington. Published by J. B. Lippincott Co., Philadelphia, 1938. Cloth, 6¼ x 9 in., 524 pages. Price $12.00.*

The purpose of this book as stated by the author in the preface is "to explain the scientific principles underlying the various phases of modern furnace design and operation, and to show how these principles may be applied to achieve operating improvement." Furnaces, for the purpose of the book, mean metallurgical and other process melting furnaces and not boiler furnaces.

The non-technical and semi-technical furnace operators will be gratified by the simplification of theoretical considerations and the avoidance of complicated mathematical formulas. The latter has been carried so far as to avoid, insofar as possible, the use of Greek letters. Nomograms are used liberally to permit ready calculations. Both chemists and engineers will be happy with the use throughout the book of both the Fahrenheit and Centigrade temperature scales, and of B.t.u. and C.h.u. for heat units.

Despite the fact that the treatment has been simplified and that practically none of the material is original with the author but is his interpretation of the published data of other workers, the technical and non-technical man will find the book valuable for the thorough discussions of the latest available material on combustion, process balance sheets, theory of gas flow, principles of heat transfer, practical solution of heat transfer problems, heat exchangers, refractory materials, and physicochemical considerations.—R. A. SHERMAN.

Foundry Practice

A MANUAL OF FOUNDRY PRACTICE. 2ND EDITION. *By J. Laing & R. T. Rolfe. Published by Chemical Publishing Co., New York, 1939. Cloth, 5¾ x 8¾ in., 312 pages. Price $7.25.*

Although a minor addition dealing with copper-base and aluminum-base alloys has been made to this edition, no attention is paid to cast steel and the book remains one practically confined to cast iron, with brief mention of malleable.

The authors have devoted 182 pages to molding and core-making technique. Testing of molding sand is passed off as unnecessary with the naturally bonded sands of England, and the reader is advised to squeeze the sand. Addition of horse manure is mentioned, so one might suggest that smelling should be added to squeezing.

The point of view is that of the very small shop—continuous casting lay-outs are dismissed in a couple of pages.

In the section on cast iron metallurgy several shot-gun plots are shown of properties *vs.* total carbon. If the authors had taken the trouble to plot these against carbon plus some fraction of the silicon, the student would not feel that control of properties is as hopeless as these figures make it out. The metallurgical discussion gives a little on high-duty iron and on calculation of charges, amid more general discussion. Under melting, the usual cupola, the Poumay and the balanced blast types, the reverberatory and the rotary furnace are mentioned. A very sketchy chapter covers chilled and malleable iron, and another, equally sketchy, touches on gunmetal, manganese bronze, aluminum bronze, and aluminum alloys.

The preface states that the book is meant to appeal equally to the student and the foundry manager, and says that "while the basic principles have been dealt with fully, the work proceeds to a comprehensive treatment of the advanced technique". On the contrary, the reviewer would call the book a most elementary one, suitable to give to an apprentice just starting in foundry work. As such, a price of say $3.50 would have been justified. The foundry manager, expecting to get $7.25 worth, will be sadly disappointed. The British Cast Iron Research Association could prepare a book of this type that would really deal with advanced technique and would probably be worth the high price of this one. We suspect that the present authors and publishers underestimate the intelligence and breadth of interest of the American foundry manager, and overestimate his willingness to pay an exorbitant price for elementary information.—H. W. GILLETT.

Other New Books

FERROMAGNETISM (Ferromagnetismus). *By R. Becker and W. Döring. Published by Julius Springer, Berlin, 1939. Paper, 7x10¼ in., 440 pages. Price 39 RM.* Fundamental, theoretical treatise on the physical aspects.

STANDARD METHODS FOR THE SAMPLING AND ANALYZING OF ALUMINUM AND CERTAIN ALUMINUM ALLOYS. 2nd Ed. *Published by Aluminum Research Institute, Chicago, 1939. Paper, 8½x11 in., 31 pages. Free to domestic consumers of aluminum alloys who maintain their own laboratory, to commercial laboratories, technical schools and colleges; all others, $1.00.* Gives details of procedure for each constituent, plus notes on interfering elements, modifications, special precautions, etc.

THE ABSOLUTE COLORIMETRIC ANALYSIS OF METALS BY THE USE OF THE PULFRICH PHOTOMETER. *Published by Carl Zeiss, Inc., New York, 1939. Cloth, 6x8 in., 103 pages. Price $2.00.* Gives complete procedures for rapid, absolute colorimetric analyses of iron, steel and non-ferrous alloys.

HANDBOOK OF CHEMISTRY AND PHYSICS—23RD EDITION. *Published by Chemical Rubber Publishing Co., Cleveland, 1939. Cloth, 4¾x7¼ in., 2,239 pages. Price: de luxe edition, $6.00; regular edition, $3.50.* Slightly larger page size than earlier editions; revisions include the Table of Physical Constants of Inorganic and Metal-Organic Compounds, and the Table on X-Ray Crystallographic Data. The Handbook as a whole is as good as ever.

German Metal Handbook

TECHNICAL METAL HANDBOOK (Metall-Technisches Taschenbuch). *By William Guertler. Published by J. A. Barth, Leipzig, 1939. 6 x 8½ in., 370 pages. Price 50 RM.*

Guertler believes in systematizing information. Several charts cover nearly the whole periodic system, showing the range of solubility of one element in another, the corrosion resistance of the elements and that of the commercial alloys, and families of curves are shown for vapor pressure, specific heat, expansion coefficient, resistance, thermoelectric power, hardness, etc., against temperature, so that the reader may get a bird's-eye view of similarities and differences. The book covers ferrous, ordinary non-ferrous and a good many of the more rare or unusual alloys.

Binary and ternary equilibrium diagrams are shown in great profusion. Commercial alloy compositions are spotted in on the charts.

The properties of heat treated alloy steels are extensively tabulated and plotted, as are those of copper-base and aluminum-base alloys. So much is condensed into the rather small plots that it is sometimes difficult to read the curves, and puzzling to figure out just what is being shown.

Some data not ordinarily included in handbooks are given; for example, the surface tension of molten metals and alloys is plotted, as is the diffusion of one metal in another in the solid state. Recrystallization diagrams are given. Data on the various carbides for sintered tools are included. Magnetic properties of steels are plotted in considerable detail. Die castings of all kinds are listed. Weldability, a table of etching reagents for all sorts of alloys, and a variety of scattered information, far too numerous to mention, are found.

In contrast to the very condensed treatment of most sections, there is a rather discursive treatment of microscopes, hardness testers and testing machines of various German makers.

One drawback is that there is no room to give references so that one has to take the data as presented without being able to conveniently trace them back to the original sources. Compared with the A. S. M. Handbook, the treatment is considerably more academic and the topics are dismissed with presentation in tables or curves without the explanations that add so much in the case of the A. S. M. book. However, an amazing amount of information is packed into the little volume and one would often have to chase through several large works to get the information on one topic that can be found there. Careful indexing has been done.

The price is high, but those libraries that aim at metallurgical completeness will find it a useful acquisition.

—H. W. GILLETT.

German-English Dictionary

GERMAN-ENGLISH SCIENCE DICTIONARY. *By Louis De Vries. McGraw-Hill Book Co., New York, 1939. Cloth, 5¼ x 7¼ in., 473 pages. Price $3.00.*

The author is professor of modern languages, Iowa State College, and he has compiled this dictionary (1st Edition) with the collaboration of members of the graduate faculty. During his 25 yrs. at Iowa State, Prof. De Vries has been closely associated with students and instructors in many branches of science, translating with them the German literature in certain fields. The need of such a dictionary was the inspiration of this volume. Though it is "for students in the agricultural, biological and physical sciences," metallurgists and metallurgical engineers will find it useful.—E. F. CONE.

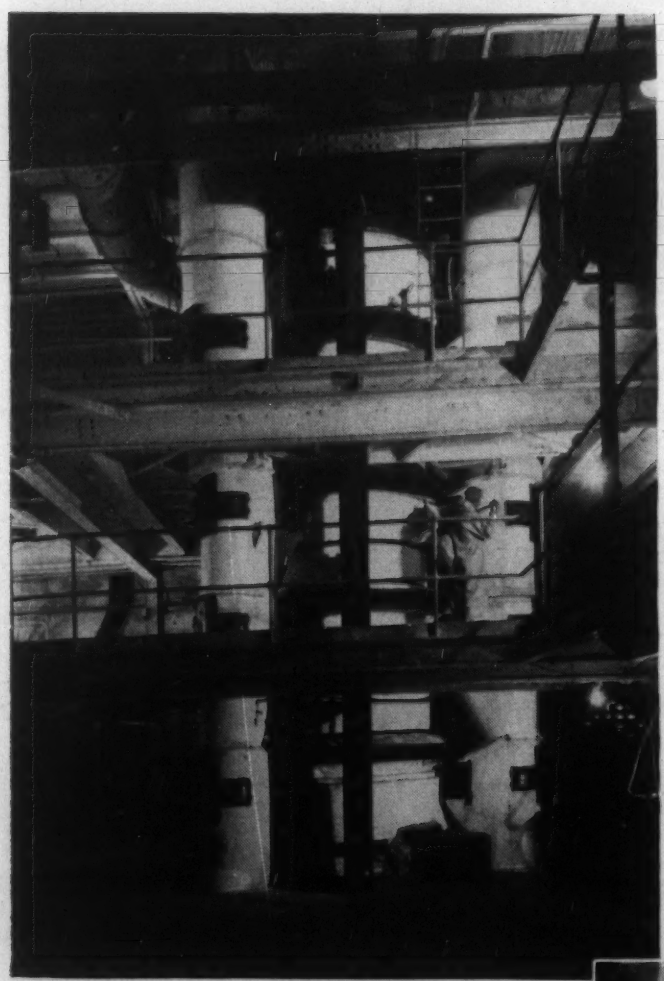
Aluminum Alloy Patents

ALUMINUM ALLOYS—PATENT COLLECTION (Aluminium-Legierungen Patentsammlung). First Supplementary Volume to Part A of Gmelins Handbuch der anorganischen Chemie, 8th Edition. *By A. Grützner & G. Apel. Published by Verlag Chemie, Berlin, 1939. Cardboard, 7 x 10¼ in., 880 pages. Price 72 RM.*

Supplementing an earlier patent list, this brings the entries of British, French, German, Swiss and U. S. Patents on aluminum alloys up to Feb. 1938, completely arranged according to the alloying elements claimed in the patents. Twenty-five pages are devoted to a list of trade names or designating numbers or symbols, with the name of the firm producing the alloy or the individual suggesting it together with the type composition.—H. W. GILLETT.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc—Number 9 of a Series



VIEW OF ELECTRO-THERMIC FURNACE

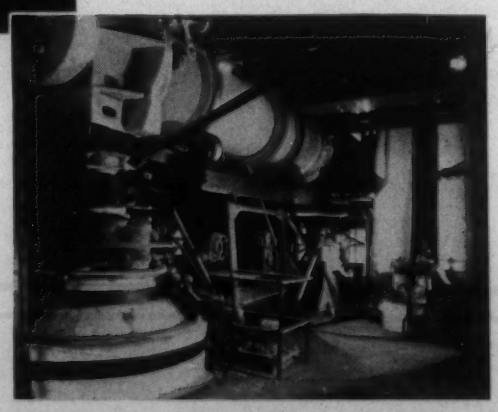
ELECTRO-THERMIC SMELTING

At the zinc smelter of the St. Joseph Lead Company at Josephtown, Pa., the furnace charge, consisting of coke and sintered ore, is fed into a gas-fired brick-lined kiln pre-heater in which the temperature is carried as high as possible without volatization of the zinc. The hot charge is fed into the top of the furnace shaft onto a rotating distributor top.

The electro-thermic furnaces themselves, are quite large affairs, about as high as a four-story building, 37 to 40 feet overall, with an inside diameter of 69 inches. They are of the charge resistor type. The charge, serving as the current carrying medium, rises to a temperature of about 1200° C and becomes incandescent. The zinc vapor formed with the carbon monoxide gas passes through the vapor ring and thence into the condenser.

Approximately 40 tons of charge enters each furnace daily. The carbon electrodes are 12 inches square and 72 inches long, and are spaced 24 feet apart vertically.

The next operation is the condensing of the zinc vapor to produce St. Joe electro-thermic slab zinc.



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CURRENT news

Light Weight Promotes Easy Riding

The belief, which exists in the minds of many, that a heavy vehicle rides more smoothly than a light one, is a fallacy. It is an actual scientific fact, perfectly capable of mathematical proof, that a light-weight vehicle with proper spring suspension can ride more easily than a heavy vehicle, according to investigations made by the Aluminum Association.

This organization, which is interested in the more extensive use of aluminum alloys for all fields of endeavor, has made a wide study of this subject. According to a communication by Charles B. Bohn, president of the Association, "Reduction of inertia forces produces a corresponding reduction in impact. The impact produced by a heavy vehicle striking a depression in the road surface is much more severe than the impact caused by a lighter vehicle striking the same obstruction. In fact, this impact is proportional to the weight of the vehicle.

"Furthermore," says Mr. Bohn, "with the heavy vehicle it is necessary to provide thicker, short-period springs which are necessarily far more severe in their action than the gentler long-period springs which can be employed by the lighter vehicle. Certainly the vehicles of today with their slower rate springs are far easier riding than their heavier predecessors. For some reason a large percentage of the public has the idea that the heavier the vehicle may be the easier it should ride and the safer it should be. As a matter of mathematics the reverse is true."

The 1939 Chemical Show

This year's Chemical Industries Exposition will be the largest since 1930, according to indications based on the amount of space now [October] under contract to exhibitors. The Seventeenth Exposition of Chemical Industries will be held at Grand Central Palace, New York, during the week of Dec. 4 to 9. Three entire floors of the Palace have been reserved and about 95 per cent of the total exhibit space is now engaged by exhibitors. Nearly 300 exhibitors representing over 40 industries have engaged space.

Chemicals, chemical raw materials, and fabricated materials for use in many industrial operations, will be featured in terms of their manufacture and use. Materials of construction cover a wide range of applications, including acid and corrosion proof linings for tanks, towers, process equipment, floors, sewers, piers and foundations. Acid, water, and oil-proof linings will be demonstrated in their uses for pickling tanks and acid disposal equipment, also for electrolytic refining tanks, and for acid sludge in petroleum refineries. The field of precision instruments will include the latest types of temperature and pressure measuring devices. One exhibit will display meters for measuring and integrating accurately the quantity of liquids passed through closed pipes—to permit knowledge of the cost of liquids metered, to facilitate control of the use of liquids, and to assure accurate manufacture of products containing a liquid.

Chemical engineers and plant operators will find a complete range of process equipment including steam jacketed kettles and tanks, made from stainless steel, monel metal, and pure nickel. Pressure vessels, deodorizers, varnish kettles, and turbine mixers will feature construction of steel and corrosion resistant alloys. Glass-lined steel equipment has made significant advances during the past two years, and these will be demonstrated at the Exposition.

The Seventeenth Exposition of Chemical Industries will be under the direction of Charles F. Roth, president of the International Exposition Co., who has been similarly responsible for the management of these expositions since the first one was held in 1915.

Eastern Photoelasticity Conference

The tenth semi-annual meeting of the Eastern Photoelasticity Conference will be held on Dec. 9, at Cambridge, Mass., under the auspices of the department of mechanical engineering at the Massachusetts Institute of Technology. All inquiries should be addressed to W. M. Murray, Room 1-321, Massachusetts Institute of Technology, Cambridge, Mass.

Morgan Construction Co.'s Research Director

Mayo D. Hersey, who has joined the staff of the Morgan Construction Co., Worcester, Mass., as research director, was for 15 years connected with the National Bureau of Standards at Washington, D. C. He organized the Aeronautic Instruments Section and later the Friction and Lubrication Section of the Bureau. Mr. Hersey served as associate professor of properties of matter at the Massachusetts Institute of Technology, also as physicist in charge of the physical Laboratory at the Pittsburgh Experiment Station, U. S. Bureau of Mines, and more recently as head of the test department in the Kingsbury Machine Works, Inc., at Philadelphia. He is a fellow of the American Society of Mechanical Engineers and a member of the Research Committee of that Society. Mr. Hersey is the author of "Theory of Lubrication."

Alloy Steels for High-Temperature Steam

More efficient modern power plants will result from the development of an alloy steel which produces a thin, protective coating when in contact with high-temperature steam, declares a report to The Engineering Foundation, New York.

Eliminating the necessity of keeping steam below the temperature at which it corrodes steel, such an alloy would serve the same purpose as house paint used to prevent the destructive action of weathering, it is indicated by results of research at Purdue University sponsored by the Foundation. It is probable that some alloy steels may develop a dense, thin, tightly adherent layer of oxidation products which will protect the underlying metal from excessive attack by steam, according to the report.

"If alloy steels can be found which develop such a protective coating, are reasonable in price, and have certain necessary physical properties, then higher steam temperatures will be possible in modern power plants and the thermal efficiency of such plants will be improved considerably," says Dr. A. A. Potter, dean of engineering at Purdue University.

Copper Depicted in Motion Picture Film

The story of the production and uses of the important industrial metal, copper, as told by an interesting and informative series of motion pictures, circulated by the Bureau of Mines, has been completed by an addition of a film depicting the processes employed in making copper wire and cable and other products. The film, entitled "Fabrication of Copper," is of the silent type and consists of three reels. It was produced in cooperation with one of the larger mining companies.

Copies of this film, in both 16-mm. and 35-mm. size, may be had for exhibition by applying to the Bureau of Mines Experiment Station, 4800 Forbes St., Pittsburgh. One should state the width of the film desired. No charge is made for the use of the film, although the exhibitor is expected to pay transportation charges.

Pulverized Coal for Metallurgical Furnaces

Because of the many engineering advancements which have been made during recent years in both the mechanical equipment and combustion methods involved in the application of pulverized coal to metallurgical furnaces, The Amsler-Morton Co., Pittsburgh, has established a department devoted exclusively to this type of engineering work.

Both methods and equipment, which are now available for the application of pulverized coal in firing metallurgical furnaces of all types, have an extensive historical background which has been rich in profitable experience. Chief advantage in the use of pulverized coal as a fuel has been found in the fact that fuel efficiency during combustion is higher than with any other method of fuel. This efficiency includes not only higher B.t.u. output per unit, but also extends into the calculations involving heating costs. Proper selection of any fuel should be made from reasons involving both B.t.u. and production costs, and it is claimed that in many new furnace installations or rebuilding operations, pulverized coal can be made to show the lowest heating cost in a majority of conditions.

The new department is prepared to design, engineer, and supervise installation of complete pulverized coal units for furnaces of all types. It will be under the direction of C. F. Herington, who has had extensive experience in the pulverized coal field for the past 20 yrs., and who is the author of a book on the subject as well as numerous articles which have appeared in technical magazines.

(Continued on page MA-685)

Advertisers' Index

Ajax Electric Company, Inc. .....Outside Back Cover
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Ajax Metal Company ..... Outside Back Cover
Aluminum Company of America.....MA 642, MA 643
American Bridge Company .....MA 650
American Car and Foundry Company.....MA 654
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American Electric Furnace Company.....MA 639
American Gas Association .....A 14
American Gas Furnace Company.....MA 656
American Hot Dip Galvanizers Assn., Inc. .....MA 667
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Arcos Corporation .....MA 664
Armstrong Cork Company .....MA 659

Baker & Co., Inc. .....MA 658
Bausch & Lomb Optical Company .....MA 673
Brown Instrument Company .....MA 674

Carborundum Company, Refractory Division Inside Back Cover
Carnegie-Illinois Steel Corporation .....A 2, A 3
Chicago Steel Foundry Company.....MA 660
Climax Molybdenum Company Insert between pages 356 and MA 635
Columbia Steel Company .....A 2, A 3, MA 650

Detroit Rocking Electric Furnace Division, Kuhlman Electric Company .....MA 638
De Witt Operated Hotels .....MA 678
Dole Valve Company .....MA 677
Dow Chemical Company, Dowmetal Division Inside Front Cover
Driver Company, Wilbur B. .....MA 677
du Pont de Nemours & Co., Inc., E. I. R. & H. Chemicals Department.....MA 637

Electric Furnace Company .....A 9
Electro Metallurgical Company .....MA 653

Fitzsimons Company .....MA 652

General Electric Company .....MA 661

Handy and Harman .....MA 664

Illinois Testing Laboratories, Inc. .....MA 658
International Nickel Company, Inc. .....A 18, MA 641

Johns-Manville Corporation .....A 8, MA 656
Jones & Laughlin Steel Corporation .....A 15

Leeds & Northrup Company .....MA 644

Maurath, Inc. .....MA 665
McKenna Metals Company .....MA 654
Meehanite Metal Corporation .....A 20
Michiana Products Corporation .....A 13
Minneapolis-Honeywell Regulator Company.....MA 674
Monarch Steel Company .....MA 652

Norton Company .....A 17

Page Steel & Wire Division, American Chain & Cable Company, Inc. .....MA 662
Pennsylvania Salt Manufacturing Company MA 668, MA 669
Pittsburgh Lectromelt Furnace Corporation.....MA 648
Pyrometer Instrument Company .....MA 650

Republic Steel Corporation .....A 6, A 7

St. Joseph Lead Company.....MA 682
Scomet Engineering Company .....MA 678
Scott Company, Henry L. .....MA 672
Spencer Turbine Company .....MA 657

Taylor Sons Company, Charles .....MA 649
Thermal Syndicate, Ltd. .....MA 679
Timken Roller Bearing Company Steel & Tube Division .....A 5
Titanium Alloy Manufacturing Company .....MA 677

Union Carbide and Carbon Corporation .....MA 653
United States Steel Corporation .....A 2, A 3, MA 650
United States Steel Products Company A 2, A 3, MA 650

Wilson Mechanical Instrument Company, Inc....MA 671

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Licensees of Nitralloy

The Nitralloy Corp., 230 Park Ave., New York, announces the licensing of the Metallurgical Laboratories, Inc., Philadelphia, Ontario Research Foundation, Toronto, Canada, and Pittsburgh Commercial Heat Treating Co., Pittsburgh, commercial heat treaters, to use its patented nitriding process. The company now has 11 agents in the commercial nitriding field, located in Camden, N. J., Detroit, Cleveland, Chicago, Boston, Cincinnati, and Milwaukee, in addition to the above cities.

● Edward H. Platz, Jr., who since 1920 has been associated with the sales of stainless and corrosion resistant alloy steels, has resigned from the Faitoute Iron & Steel Co. to join the alloy steel sales department of Lebanon Steel Foundry, Lebanon, Pa.

● The Great Lakes Carbon Corp., which at present has under construction at Niagara Falls, N. Y., a plant for the manufacture of graphite electrodes, amorphous carbon electrodes and graphite anodes, announces the appointment of George O. O'Hara as sales manager of the electrode division.

● Moffett Field, near Sunnyvale, Cal., has been selected by the National Advisory Committee for Aeronautics as the site for the new aeronautical research laboratory authorized in the Third Deficiency Act approved Aug. 9, 1939; 54 sites were brought to the Committee's attention within the time limit specified by law.

Molds of Electro Deposited Iron

Development of a new process of "electroforming" iron molds which may be used to reproduce objects as delicate as human hands, leaves, and phonograph records is reported to the American Chemical Society by a group of Detroit chemists of the United States Rubber Co. A striking application of the process is in the production of dies or molds by which photographs can be transferred to iron, according to the chemists, Arthur W. Bull, J. W. Bishop, M. H. Orbaugh, and E. H. Wallace. Patterns which have 7,400 tiny lines to an inch of surface have been reproduced in electrodeposited iron.

The process consists of coating the object to be copied with a layer of electrically deposited iron, usually a little over ⅓ in. thick, separating the metal from the object, and filling the mold with material from which a reproduction is to be made. The electro-deposition of iron takes about 2 weeks.

The process is said to offer quick and perfect reproduction of the most intricate details, usually with a very considerable saving in cost, the report declares. It seems probable that this method will find extensive application in the preparation of many stamped articles. It permits the reproduction of rare designs and old pieces where only a single sample may be available. Where it is desired to make duplicates of an existing mold, a pattern, preferably of a suitable metal, is prepared from the mold and plated with iron. Some molds for rubber goods have undercuts, and in these cases it is necessary to make the patterns of rubber so that they can be removed from the mold without breakage. A rubber tire to be duplicated is rendered conductive by graphite dusted on its surface, after which it is placed in the electro-forming tank. When the desired thickness of metal has been formed on the pattern, the electroformed shell is removed, weighing about eighty pounds. The shell is welded into a heavy back or case after which it is ready for service.

● The Firth-Sterling Steel Co. has announced the election of officers to American Carbide Alloys Corp., its newly acquired and wholly owned subsidiary. L. Gerald Firth, president of Firth-Sterling, was elected president of the new company, and G. A. Jacobs of the company's Detroit office was made first vice president. It was also announced that the main office and works of the new company will be located in Detroit. Mr. Firth, president, reported that all equipment and stock located at American Carbide's plant at Lewiston, Maine, is being transferred, and the future manufacturing of the new sintered titanium carbide cutting material will be carried on in Detroit, and at Firth-Sterling's plants in McKeesport.

Dr. Hoyt Joins Welding Research Committee

● Dr. S. L. Hoyt of Battelle Memorial Institute, Columbus, Ohio, has been appointed chairman of Committee IV, High Alloy Steels, Industrial Research Division of the Welding Research Committee of which Col. G. F. Jenks is chairman. Dr. Hoyt will present to the Committee a wealth of experience in this field. He has already gained an enviable reputation for his ability as a research worker and as an executive in handling rsearch problems.

J. & L. Bessemer Flame Control

With Bessemer flame control equipment now being installed on the 2 converters at its Pittsburgh Works, the Jones & Laughlin Steel Corp., Pittsburgh, will soon have all of its 5 converters operating under this new scientific control method which features the use of an arrangement of photoelectric cells as a part of the control system. The continued use of this J. & L. invention, on which patent applications have been filed, is further proving its earlier success in controlling the Bessemer process to a degree of uniformity never before attained, says the company.

With growing experience in the use of the Bessemer flame control, J. & L. operators are reaching a new and higher skill in maintaining uniform temperatures and uniformly reproducible quality from heat to heat, it is said. Records of heats blown are showing narrowed range of temperature of the steel at the end of the blow; improvement in freedom from surface defects; sounder structure in the center of billets and bars; and higher degree of workability in machining, forming, and fabricating. The steel produced for screw stock under Bessemer flame control methods is showing gratifying results in uniform machinability, cutting speeds, feeds, and appearance of the finished product.

In addition to the flame control method already developed and in use, other factors affecting the quality of Bessemer steel have been recognized and methods of controlling them are being rapidly perfected for further improvement in the product.

● The gold production of the United States for the year 1939 will exceed that of 1938 by over 270,000 fine ounces, Merrill E. Shoup, president, Golden Cycle Corp., Colorado Springs, Col., predicted in an address at the 6th Annual Coal Convention and Exposition of the American Mining Congress. The world outlook for 1939, insofar as the production of gold is concerned, points to the same upward trend which has risen steadily from 19,317,961 ounces in 1929 to 37,109,391 ounces in 1938, he stated.

● Charles L. Huston, Jr., assistant staff supervisor of employment at The American Rolling Mill Co., Middletown, Ohio, has resigned, and has joined Lukens Steel Co., Coatesville, Pa., as director of personnel. The appointment was effective Sept. 1 and Mr. Huston will be in charge of personnel activities of Lukens and its divisions, By-Products Steel Corp. and Lukenweld, Inc.

● The appointment of Frederick M. Gillies as general superintendent of the Indiana Harbor Works of Inland Steel Co. has been announced by James H. Walsh, works manager. He succeeds Henry R. deHoll, whose retirement has just been announced. Mr. Gillies first came to Inland in 1922 as superintendent of the 100-in. plate mill, and has been in charge of several different divisions of Inland's Indiana Harbor Works. For the past 9 yrs. he has served as assistant general superintendent of the Indiana Harbor Plant.

● The American Standards Association recently announced approval of a new standard for Dimensions and Materials of Wrought-Iron and Wrought-Steel Pipe and Tubing which should result in considerable savings in cost and convenience to manufacturer and user industries. This standard has been tested through a 3-yr. period of trial in actual use and has already demonstrated its practical value.

Mechanical Engineers' 60th Annual Meeting

Broadening the usefulness of the mechanical engineering profession will be the keynote of the 60th annual meeting of The American Society of Mechanical Engineers to be held in Philadelphia, Dec. 4 to 8, 1939. An attendance of more than 3000 engineers is expected.

All functions of this meeting, the first one held outside of New York City since 1890, will take place at The Bellevue-Stratford Hotel. Present plans call for 35 technical sessions at which 105 papers will be presented; a get-together smoker and introduction of 1940 officers of the society on the evening of Dec. 5; the annual banquet and conferring of medals and awards on Wednesday, Dec. 6; college reunion luncheons and dinners for engineers on Thursday, Dec. 7; and the Fourth Annual A. S. M. E. Photographic Exhibit all week.

● The Meehanite Metal Corp., Pittsburgh, has granted Meehanite manufacturing licenses to the Vancouver Engineering Works, Ltd., Vancouver, B. C., and to the Washington Machinery & Supply Co., Spokane, Wash.

● The Meehanite Research Institute of America, Inc., the cooperative research organization composed of Meehanite manufacturers in the United States and Canada, will hold its next annual meeting at the Hotel Statler, Detroit, Nov. 1 to 3.

● Bradley Stoughton, consulting engineer, Lehigh University, Bethlehem, Pa., announces recent additional facilities in physical metallurgy, physical chemistry, and mineralogy, for patent and other causes.

Free Service Department

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd St., New York.*

POSITION WANTED: Welding Metallurgist. Age 34, does not possess a college degree but has had fifteen years experience in the field of analytical chemistry and physical metallurgy. For past 11 years has been connected with the welding industry in a research and development capacity. Has constantly been and still is steadily employed but is very desirous of making a change. Box MA-164.

POSITION WANTED: Sales Representative. In Detroit, covering Michigan, Northern Ohio and Indiana, desires connection with manufacturer interested in this area. Have 20 years' successful selling experience with mechanical and metallurgical knowledge. Box MA-165.

POSITION WANTED: Practical Foundry and Industrial Engineer. Age 32, married. General experience in research and experimental problems, malleable foundry operations, process control, production problems, special equipment, plant layout, renovation, modernization, maintenance. Prefer young growing concern who can best utilize ambitious, practical, all-around "idea man" who can produce. Employed, but available two weeks notice. Box MA-166.

POSITION WANTED: Chemist. B.S. '32, M.S. '33. Four years' experience as analytical chemist in field of ferro-alloys. Two years' development engineer in oxy-acetylene welding and cutting field. Experienced inspector of welded pressure vessels. Available on short notice. Prefer midwestern location. Box MA-167.

POSITION WANTED: Graduate metallurgist with industrial experience. Capable writer and public speaker. Would like position with established concern. Box MA-168.

POSITION WANTED: Physicist, Ph.D. Institute of Technology, desires position in research or testing laboratory. Experience in magnetic alloys and X-ray material testing, development or measuring devices and instruments for special purposes. Excellent training in all fields of physics. Available immediately, single, 30. Box MA-169.

POSITION WANTED: Development Engineer with twenty years experience wants appointment requiring solution of difficult technical problems relating to metal processing, forming, or finishing, added utility and adaptation of specific new uses. B x MA-170.

trends

By Edwin F. Cone, Editor

Heat-Treating Equipment

The trend in large automobile and other plants, where heat-treating is a major operation, is to concentrate as much as possible these operations in one plant. Closer regulation and broader standardization are thus more generally assured. An outstanding example of this is the new Ford Tool and Die shop which is described in this issue.

High-Speed Steel

An interesting fact in the article above referred to is the tendency of Ford engineers to use an 18-4-2 high-speed steel in preference to the 18-4-1 steel for many of their operations.

Total Electric Steel

According to a private but highly authoritative statistical record, data show that the percentage of the output of electric steel ingots and castings of the total ingots and castings was 2.34 per cent in 1938 or the highest on record. The percentage in 1929 was 1.69 per cent with the expansion to 2.34 per cent gradual each year.

Electric Steel Castings

The same record referred to in the foregoing shows that the total quantity of steel castings made by the electric furnace process was 200,516 gross tons last year. The high since 1929 was 369,073 tons in 1936. The trend has fluctuated with that in ingot production.

Stainless Steel

Such rapid progress has been made in the uses of stainless steel that forecasts are difficult, says a circular of the International Nickel Co. Probably the trend is best indicated by its increasing use in airplane construction where the specifications are daily becoming more severe.

Gold

American gold output in 1939 is estimated to exceed 1938 by 270,000 fine ounces. The same upward trend is indicated for the world in 1939. Ten years ago, or in 1929, the total was 19,317,961 oz. and in 1938 it was 37,109,391 oz.—a gain of over 92 per cent.

Airplane Expansion

In a little more than 30 years, according to Assistant Secretary of War Louis Johnson, airplanes have increased from a maximum speed of 45 miles per hr. to one of more than 450 m.p.h. or 10 times; they have developed from a weight of about 800 lbs. to one of more than 80,000 lbs. or over 100 times; aircraft power plants have increased from 20 h.p. to more than 2,000 h.p. or more than 100 times. Metallurgical engineers can readily appreciate the role that metals are playing in this trend.

Steel vs. Pig Iron Capacity

The trend in the expansion of the steel-making capacity of this country is decidedly greater than in pig iron. Because of this, the role of scrap in steel production takes on increased importance. For example, from 1920 to 1933 the annual steel making capacity increased about 30 per cent, said the secretary of the Institute of Scrap Iron and Steel in a recent speech. In the same period blast furnace capacity expanded only 2 per cent. This trend has practically been maintained up to the present. This means increased reliance on scrap for steel making.

Finished Stainless Steel—Exports

Demand for American stainless wrought steel from foreign countries is growing apace. An analysis of official data shows that our exports of "stainless steel" bars, sheets, plates and strip (hot and cold rolled) in 1937 were 446,980 lbs. per month and in 1938 they were 512,719 lbs. monthly. To Aug. 1 this year, the volume, while not so large as in 1937, has been 461,620 lbs. each month. Strip predominates this year with sheets second, bars third and plates fourth.

Exports of Finished Alloy Steel

Expansion in our exports of alloy steel, including stainless, is decidedly upward. An analysis of official export data shows that our exports of these products this year to Aug. 1—of ingots, blooms and billets, bars; plates; sheets; strip; castings and forgings—were at the rate of 6,834,500 lbs. per month. This exceeds the corresponding volume of 5,075,262 lbs. in 1938 and of 5,508,593 lbs. monthly in 1937. These trends are significant, but will probably be upset by the war.

Buying by Railroads Increases

Railroad equipment buying is on the increase. The 152 locomotives purchased in the first half of this year is double that (75) for the same period in 1938 and the 9,077 freight cars represent a gain of 13 per cent over the 8,024 ordered in 1938 to July 1, according to *Railway Age*. Again the 135 passenger-train cars booked is 26 per cent up while rail orders (515,808 tons) for the same period were almost three times last year's first half.

Tin

World tin production in the first 7 mos. of 1939 averaged 11,000 tons per mo. as against 12,370 tons per mo. in 1938. In view of the world situation, from an economical as well as a military standpoint, this downward trend must be reversed. On the other hand apparent world consumption to Aug. 1, 1939, was 12,440 tons per mo. as contrasted with 12,600 tons monthly in 1938.

New Equipment and Materials

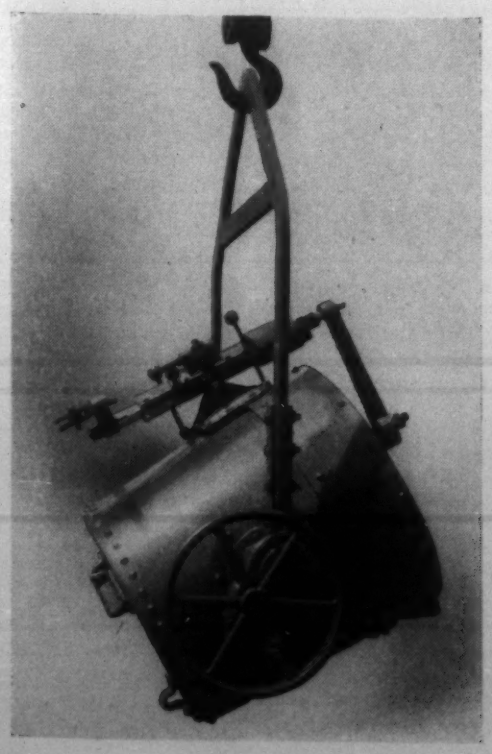
Worm-Geared Ladles

The Treadwell Construction Co., 649 South 12th St., Midland, Pa., has recently introduced a line of worm-geared ladles, ranging in capacities from 2 to 5 tons, for efficient handling of molten steel and other metals. Salient construction features include a stopper rig for drawing pure, slag-free metal from bottom of ladle and a geared turning device so designed as to prevent any movement of the ladle due to weight of molten metal.

The stopper rig, or harness, consists of a carrier arm, slide, guide, and stopper rod. The latter extends down through the metal to the bottom of ladle. It has a sleeve on it made of fire clay or heat resistant terra cotta with graphite plug on bottom. When the plug is raised, the molten metal is discharged through the bottom of ladle and the slag, which floats on top, is prevented from getting into the ingot mold or casting.

The turning mechanism, which is self-locking, consists of a worm wheel mounted on the ladle trunnion and integral with the bail. This gear in turn meshes with a worm of sufficiently low pitch to prevent any movement of the ladle. The hand wheel is mounted on a cross shaft with suitable gear for operating the worm. Roller type bearings are used and the entire mechanism is mounted in an oil tight case so designed that all gears operate in an oil bath.

The illustration shows a 4-ton ladle suitable for handling molten steel. It is made of 3/8 in. steel plate, is 4 ft. high and 4 ft. in dia. Similarly constructed ladles with less gear clearance are available for handling molten tin, babbitt, lead, zinc, etc. The manufacturer will gladly furnish complete information on request.



Manufacturers are invited to send to the Editor items which are suitable for this Department. Illustrations are acceptable, preferably in the form of cuts not more than 2 in. wide.

Electrical Contacts from Powdered Metals

Electrical contacts, possessing the high conductivity of pure silver as well as the low, constant resistance, are now being marketed to manufacturers of electrical equipment under the trade name of "Gibsiloy" by the Gibson Electric Co., 530 Blvd. of the Allies, Pittsburgh.

Because of its ductility, Gibsiloy—a powdered metal composition—may be formed into a wider variety of shapes than similar materials which, owing to their brittleness, must be cast to form. Moreover, Gibsiloy may be punched, machined, drilled, tapped and otherwise worked as easily as ordinary alloys, it is claimed. Some of the many shapes available, both of solid Gibsiloy and with Gibsiloy attached to base metal backings, are shown in the accompanying illustration.

Gibsiloy contacts are claimed much harder than contacts made of pure silver and resist wear to a far greater degree. Hardnesses range from that of pure silver to 200 Brinell B scale Shore Scleroscope for some grades of silver-nickel-tungsten. They are free from galling and their high arc resistance greatly reduces welding or sticking.

The most common forms of Gibsiloy are silver-nickel, silver-nickel-cadmium, silver-nickel-tungsten, silver-nickel-molybdenum, silver-tungsten, and silver-molybdenum. Each form is produced in different grades possessing varying physical properties. Certain forms, particularly silver-nickel-cadmium, greatly reduce transfer of metal from one contact to another on D.C. circuits.

Airco Gas Cutter

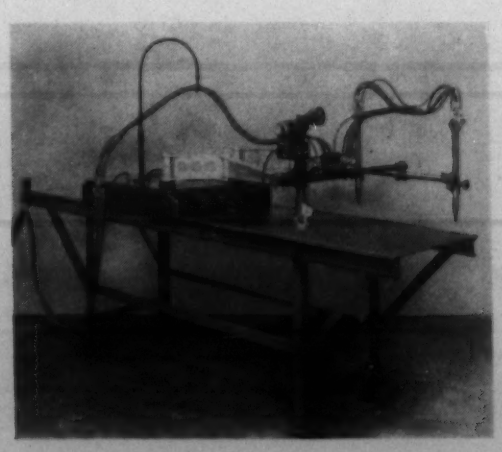
The extreme flexibility of use of the new "Airco No. 10 Planograph" announced by Air Reduction Sales Co., 60 E. 42nd St., New York, is claimed demonstrated by its ability to gas cut straight lines, rectangles, circles and irregular shapes from ferrous metal of any thickness within the present practical limits of the cutting torch. Although a stationary-type machine, the new unit can readily be moved by crane to different localities in the shop.

The No. 10 Planograph consists of a tracing table upon which the carriage travels. The torches and tracing devices are supported on the carriage. Operating on either 110 or 220 volts a.c. or d.c., the unit requires a minimum of floor space. Even including the work table, the new planograph requires a working area of only 5½ by 10½ ft.

Cutting range in single torch operation is 24 in. wide by 72 in. long. This length can be increased indefinitely in multiples of 72 in. by utilizing additional tracing tables. Maximum diameter of circle cuts is 24 in. When two torches, mounted on the regular operating bar, are employed for simultaneous cutting, the cutting area for each torch is 12 in. wide by 72 in. long. Two circles each up to 12 in. diameter can also be cut with the torches mounted in this manner. By using an auxiliary bar, the cutting area of each is 24 by 24 in.

The tracing device for manual tracing can be locked so that it will, without manual guiding, travel in a straight line in any desired direction. Provision is also made at the tracing device head for connecting a lamp to light the work table.

The gas control unit on the No. 10 Planograph is centrally located. A knob handle operates cams, progressively arranged, one each for the pilot light, acetylene (or other fuel gas), oxygen preheat and cutting oxygen. One complete cycle lights and cuts off in proper sequence. Handwheels mounted on either end of this unit permit lighting or extinguishing the torch from either end of the tracing bar.



Continuous Unit for Cleaning Strip Steel

The electrochemical processes division of Blaw-Knox Co., Blawnox, Pa., announces the development of a continuous unit for cleaning strip steel before annealing. The cleaning principle is said to be new and electro-mechanical in nature, providing for a faster and sharper cleaning action with an appreciably lower consumption of current. These advantages reflect themselves in lower cleaning costs.

An outstanding feature of the design is the short length of cleaning line, being only 95 ft. from center to center of payout and windup reels. Despite this economy in space, the unit is designed to clean 1500 ft. of strip per min. A cold mill type of electrical strip tension control for the full length of the line has the objective of eliminating loss or delays due to folded or damaged strip. There is fully automatic control of the solution and temperature. It is also reported by the company that electrocleaners now in service can be converted to the new Blaw-Knox type.

Accurate to 1/3000th Of a Hair

Science has now attained the greatest accuracy the world has ever known with a machine which measures to the 1,000,000th part of an inch. Called the "profilograph", it employs a magnified beam of light to record microscopic variations in size, and is used in the laboratories of the Timken Roller Bearing Co., of Canton, O., to check the precision of its testing gages. These gages insure an accuracy of 1/10,000th of an inch in the manufacture of the company's tapered roller bearings. To picture the minuteness of a millionth of an inch, imagine a human hair split into 3000 equal parts. One part would be approximately equivalent to a millionth of an inch. For further data, write Salvage & Smith, 16 East 48th St., New York, N. Y.

DEEP *cases* in SHORTER Treating Time

use du Pont CARBURIZING SALT

Deep high carbon cases (0.035" and over) are easily obtained on a wide variety of steels in about one-half the usual time for pack hardening and other methods. That is why prominent manufacturers are now using new du Pont Carburizing Salt. At the usual carburizing temperatures this specially prepared cyanide mixture produces high-carbon cases with a very low nitrogen content. Accurate control of the case depth is possible because of the uniform rate of carbon penetration, high conductivity and unusual stability of du Pont Carburizing Salt.

DU PONT

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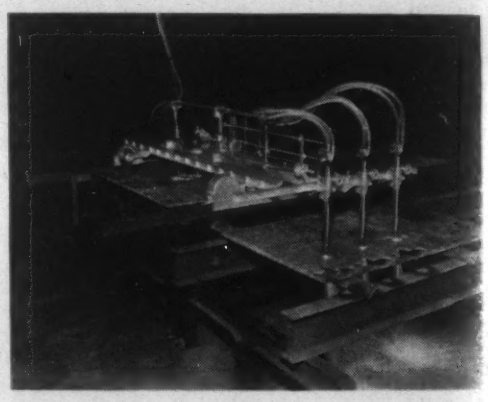
The R. & H. Chemicals Department
Wilmington, Delaware
District Sales Offices: Baltimore, Boston, Charlotte, Chicago, Cleveland, Kansas City, Newark, New York, Philadelphia, Pittsburgh, San Francisco

Oxy-Acetylene Cutting Machine

A newly designed, stationary oxy-acetylene cutting machine, which is claimed to offer almost unlimited possibilities in cutting irregular shapes, rings, circles, and straight line bevels, and performing several varieties of multiple blowpipe cutting, has been announced by The Linde Air Products Co., 30 East 42nd St., New York. Known as the "Oxweld CM-23 Shape-Cutting Machine," this recent addition to the field of steel fabricating equipment includes many new operating advantages and material refinements in addition to the fundamental operating principles of the Oxweld CM-2 Shape-Cutting Machine, which the CM-23 machine now replaces.

The CM-23 machine is designed to cut shapes either automatically with templets or guided by hand direct from a full scale drawing. It is available in two sizes, with cutting ranges of 54 and 81 in. in width by 12 ft. in length. The maximum cutting area is slightly less when the machine is used for hand-tracing. Circles ranging in diameter from 6 in. to 49½ in. (for the smaller size machine) and 72 in. (for the larger size) can be cut. Both sizes of the CM-23 may be extended indefinitely longitudinally by the addition of 6-ft. lengths of machine legs and rails, and work support. In addition, the machine can be supplied, on special order, with a transverse capacity of 108 in. or 135 in.

Although the operating principles of the CM-23 machine remain the same as those of the CM-2, certain improvements of the new machine are said to make for greater cutting precision, while still other improvements are designed to simplify the duties of the operator.



"Agalloyed" Tubing

The development of a steel tubing, said to be comparable in quality and appearance to cold drawn seamless tubing and competitive in initial cost with joined seam tubing, has been announced by AGA Metal Tube Co., 1029 Newark Ave., Elizabeth, N. J.

The tubing is produced by joining spirally wound cold rolled steel strip in a hydrogen atmosphere high-frequency induction furnace. Constant pressure is applied to the spiraled strip at the moment of joining, and is not relieved until the temperature of the tubing is reduced below the freezing point of the bonding material, thus assuring a perfect joint. Decarburization is entirely eliminated, it is said, even in high carbon steels as the actual heating and cooling cycles involve seconds rather than minutes.

The tubing can be made in all straight carbon steels as well as in Cr-Va, Cr-Ni and Cr-Mo steels. Sizes manufactured at present range from ⅝ to ⅛ in. O.D.; wall thickness ranges from 0.042 to 0.010 in. The tubing, which is said to possess particularly uniform wall thickness, is available in various tempers, depending upon the use to which it is put. It is furnished cold drawn and can be bent, coiled, expanded, flared, flanged, swaged, spun, machined, or welded. It will stand, it is said, severe forming and with but little preparation the surface is ideal for plating. Average physical properties of annealed tubing are high.

This tubing is used in golf shafts, fishing rods, radio antennas, lighting fixtures, automobiles, refrigerators, bicycles, ski poles, and other numerous household and industrial articles.

A 200 Ampere Arc Welder

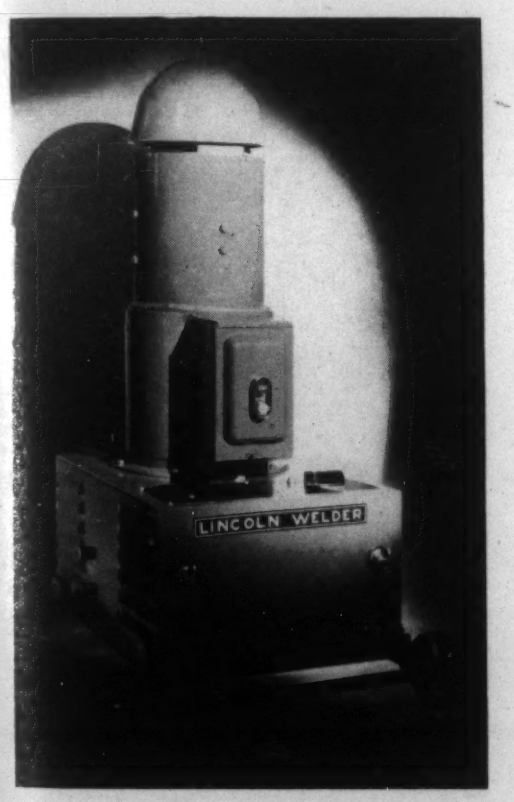
A new 200 ampere arc welder of the Lincoln Junior type with a range for many welding applications, ordinarily associated with considerably larger welding equipment, is announced by The Lincoln Electric Co., Cleveland. This new machine, because it is of motor-generator d.c. arc type, will weld virtually all metals and alloys and do hard facing work, according to the manufacturer. Its speed of operation and quality of results are reported to be exceptionally high for work of all sizes, under all operating conditions.

The new welder is single-operator, variable-voltage type and can be used with either bare or shielded arc type electrodes. It has a current range of 60 to 250 amps. for welding duty.

A special feature, now available for the first time on small arc welding machines, is Lincoln's patented dual continuous control. A further important feature is its insulation. Use of Class B insulation at proper points accounts for the ability of the unit to withstand sustained overloads. The Class B insulation used in this welder contains no inflammable material whatever.

The motor is the "Linc-weld" squirrel-cage inductype for across-the-line starting. Construction is arc welded steel. The welder occupies less than 4 sq. ft. of floor space. A lifting lug facilitates crane handling.

Because of its advanced features, many of which have not heretofore been available on small arc welders, this new Lincoln product will, it is expected, greatly simplify the economical application of arc welding.



Wilson Electric Arc Welder

A new single operator motor-generator arc welder, requiring only one control device for operation, has been announced by Wilson Welder & Metals Co., Inc., 60 East 42nd St., New York. Known as the Wilson "Hornet," this welding machine employs for its control a single, simple handwheel located on top of the unit. Adjustment of this handwheel permits the operator to obtain an infinite number of current settings. Dial markings are so accurately calibrated that meters are not required, it is claimed. Single-pole control design assures a current output that will not vary, resulting in a constant, uniform arc at all times. Accidental reversal of polarity is impossible because the electric current is so designed that a small snap switch must be flicked by the operator to change the polarity.

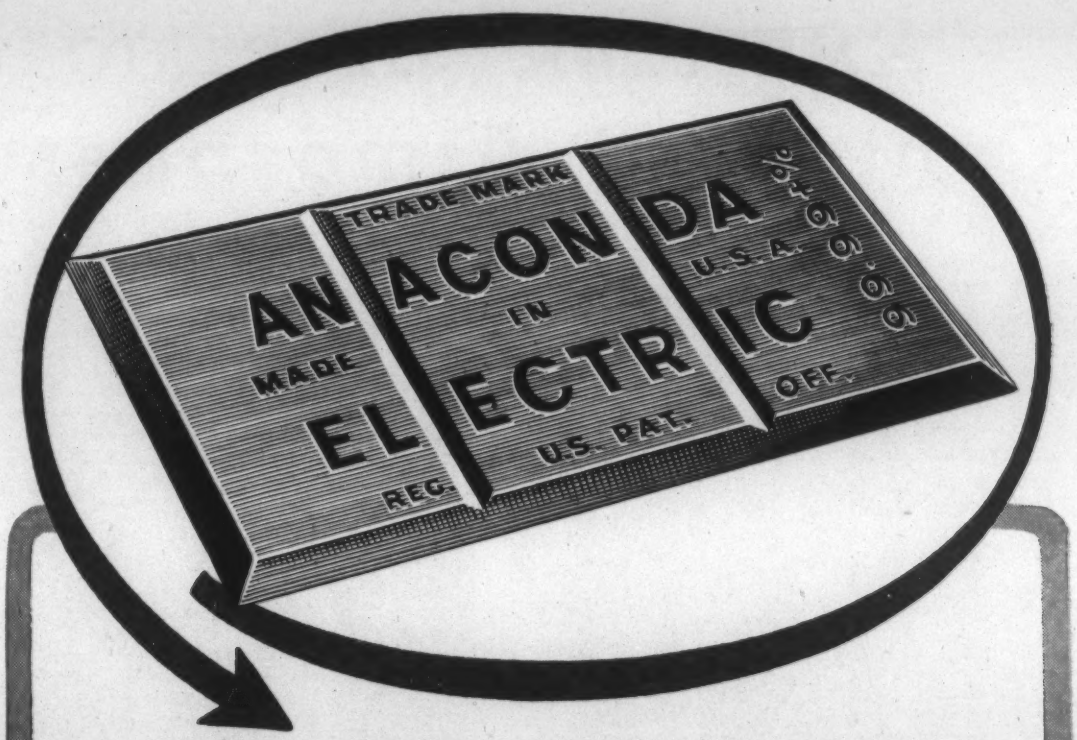
The "Hornet" is a two-bearing unit, with motor rotor and generator armature mounted on a common shaft. Adequate ventilation is furnished by propeller blades attached to the revolving shaft. Although shielded arc electrodes are recommended, the "Hornet" will operate with equal efficiency where bare electrodes are used.

Plating Rack Coating

The Michigan Chrome Co., 6340 East Jefferson Ave., Detroit, has recently introduced a new protective coating material to be used for insulating plating racks. This coating, known as "Miccrolite," can be applied faster and will air dry much more quickly than the usual plating rack protective coatings, it is claimed. The dipping speed is approximately 5 times faster than that of the other coatings. Under average drying conditions, one coat can be applied each hour. The 7 coats recommended to prepare the racks for plating use can be applied in one day and the racks can be used the following morning.

This material has been developed as an all-purpose protective material for plating racks, used in any solution or acid or in any process. It is not affected through the complete cycle of plating. It is effective in all types of cleaning operations. It contains no pigments but is perfectly clear in appearance, both before and after it is applied.

Miccrolite is described as of low viscosity which permits the application of extremely thin, yet effective, coatings. No thinner is required except for an occasional surface spraying when racks are being dipped. It assures smooth, uniform coatings, and there is practically no dripping of the material after the racks have been dipped. Webbing or pocketing between contact points is reduced to a minimum. It can be applied either by hand or machine dipping, and is applied directly on the metal surface of the rack, with no treatment necessary other than cleaning the surface to be coated. No tape or any special treatment is required. If a rack should become damaged in process, it is only necessary to touch up the damaged section, the patch becoming an integral part of the entire coating.



Special High Grade

99.99+% ZINC

To producers and users of zinc die castings, we say simply this: *Specify Anaconda Electric,* for you may be sure that every slab is of uniform high purity. Electrolytic refining does it. 39393

Shipping Point: Great Falls or Anaconda, Montana

ANACONDA
from mine to consumer

ANACONDA SALES COMPANY

25 Broadway, New York

Subsidiary of Anaconda Copper Mining Company

Atomic Welding Paste and Rod

A new, most satisfactory method to atomically weld practically all non-ferrous metals, including aluminum, in connection with aluminum, and aluminum alloys has been made available by the Colonial Alloys Co., Philadelphia. Gages from 0.005 to 0.050 in. lend themselves more readily to this method of securing an atomic welded bond, without the use of welding apparatus or experienced welders, it is claimed.

The method employed in this welding is described as a comparatively simple one, which when mastered, lends itself to very fast operation in production work, at comparatively low cost. "Colalloy Atomic Welding Paste" is simply brushed onto the metal at the points where the welding is to take place, rod applied, then subjected to heating at about 450 deg. F. In a matter of seconds, the weld is completed. The lighter the gage of metal, the faster the action, and the stronger the weld. The bond is claimed atomic, not just adhesive, and while this process is not offered as a substitute for welding by regular methods now in use, this form of welding can be used most effectively in many applications which heretofore presented a problem in the joining of metals by other than mechanical methods.

Colalloy Atomic Welding is especially recommended for light gage metal joining, for it does a satisfactory job in most cases, without the drawbacks of hard-to-handle and costly welding apparatus and operation, and with none of its drawbacks.

Colaweld can also atomically weld most other metals, both ferrous and non-ferrous, like Monel, nickel, copper, brass, bronze Everdur, nickel-silver, aluminum, duralumin, lead, zinc, low and high carbon steels and stainless steels.

All-Welded Steel Ladles

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., has received its first 2 all-welded open-hearth ladles for service at its Ensley Works. These ladles were built by the Blaw-Knox Co., Blawnox, Pa.

Each ladle has a capacity of approximately 140 net tons, and weighs 39,250 lbs. without the lining. The dimensions are as follows: Top, major axis, inside, 11 ft., 3¾ in.; bottom, major axis, inside, 10 ft., 0¼ in.; depth, inside, 11 ft. 2¼ in.; and trunnion center to center, 12 ft., 4 in.

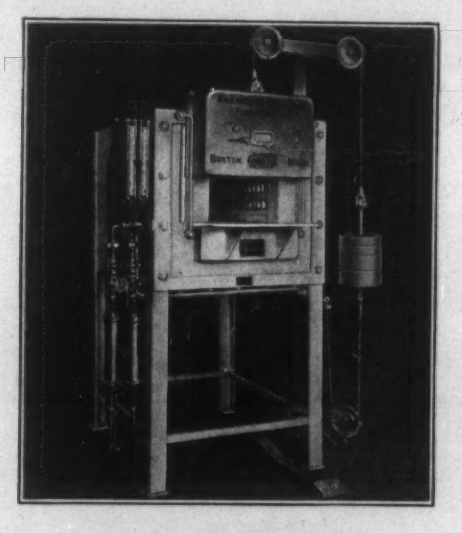
With respect to distinctive design features, the Blaw-Knox ladle is truly all-welded, including the trunnion construction and reinforcement members. The trunnions proper are solid forgings of 12 in. diameter with a shank on each about 16½ in. A further point in the design is the attachment between these ribs forming the trunnion pads and the heavy stabilizing rings that girdle the ladle. This form of construction, following a fundamental theory of design, definitely ties together the shell, the trunnions, and the stabilizing rings, which all act together to carry the load.

Among other features of the design is the use of a uniform thickness of plate throughout the shell. The bottom of the ladle is butt-welded to the shell and has a dish form rather than the flat shape common to some of the older type ladle bottoms. Long service usually deflects a flat bottom to at least a semi-dish, and it is almost impossible without excessive reinforcement to prevent this occurrence. Consequently, it is thought to be an advantage to initiate the dish design.

"AMERICAN" ELECTRIC Controlled Atmosphere FURNACES

PREVENT ..... Scaling Burning Decarburization

REDUCE ..... Dimensional Change Grain Growth



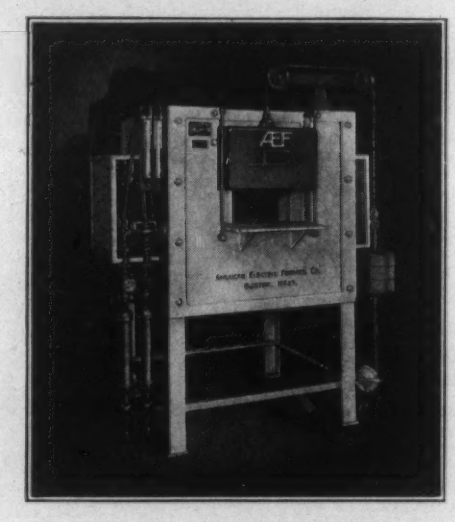
B-20 FURNACE

Chamber 12"x24"x10"

for

Preheating, Hardening, Annealing

Model B "AMERICAN" Electric Furnaces are designed primarily for general heat treating operations up to 1900° F. They are particularly suited for preheating high speed steels where atmospheric control is essential.
These furnaces completely satisfy the variable demands of the tool room as well as the requirements of the production line for long life, low upkeep, and positive results.



HB-10 FURNACE

Chamber 8"x12"x5"

for

Heat Treating High Speed Steel

Model HB "AMERICAN" Electric High Speed Furnaces are designed particularly for the high temperature operation required by high speed steels and are adapted for practically any heat treating process between 1900° and 2500° F. They are equally well fitted for use in the tool room with its infinite variety of work or in the production line where quantity is paired with quality.

"AMERICAN" Atmospheric Control as incorporated in "AMERICAN" controlled Atmosphere Furnaces provides full 100% control of the curtain across the door opening and the atmosphere which surrounds the work. Atmospheric control is equipped with dehydrating cylinders for removing moisture from air and gas. Curtain is automatically synchronized with door opening.

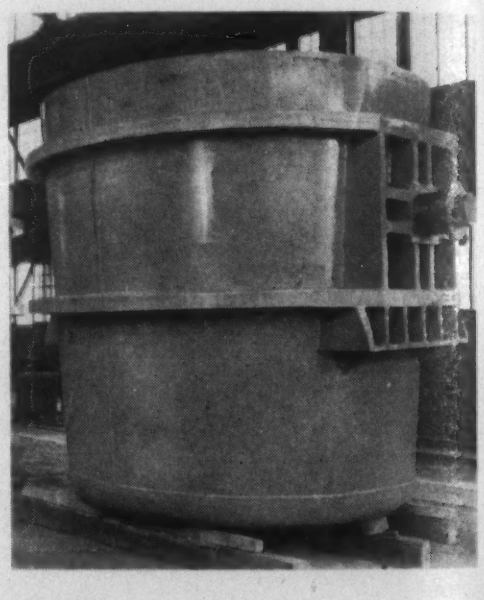
U. S. Patent Nos. 1,357,790, 1,399,638, 1,652,200, 1,819,554.

ASK FOR BULLETINS 42 and 25.

American Electric Furnace Company

29 Von Hillern St. **Boston, Mass.**

All types Industrial Furnaces



Self-Cleaning Filters

New "Automatic Self-Cleaning Filters" which have been developed by S. F. Bowser & Co., Inc., Fort Wayne, Ind., for handling lubricating oils, coolants, and many other industrial liquids. With modern high speed production, efficient lubrication is a factor of utmost importance—for filters are required to handle large quantities of liquids and must often operate over long periods of time. With the introduction of this new type filter, stops for cleaning are relatively few, and when necessary cleaning is exceptionally simple.

The filter elements are available in different porosities, depending upon the degree of filtration which the customer desires, or which the particular job demands. Various capacity sizes are also available, and of particular interest is the fact that the capacity of each size can be increased by the addition of individual filter elements (up to six) which can be inserted at any time.

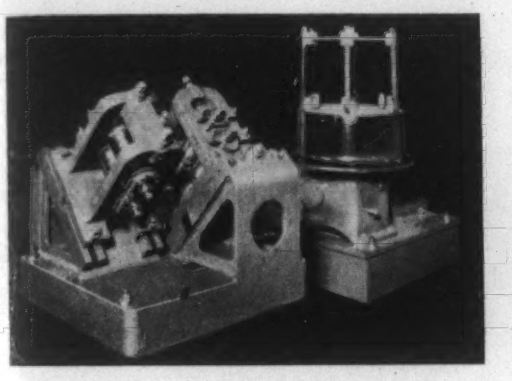
Due to the fact that the reduction drive operates at the same speed as the motor, it is readily apparent that in the presence of abrasive materials considerable wear would result. In order to obviate this condition, the high speed gearing is so located that abrasive material in the liquid does not reach it; in fact, the gears operate continuously in a bath of lubricating oil. The company states that these filters have been thoroughly tested in actual service, and are performing with high efficiency.

Planishing Mill

A new development by the Lewis Foundry & Machine Division of Blaw-Knox Co., Blawnox, Pa., looks like a pilot mill but is really a production unit of novel type. It is a planishing mill equipped with a coil winder which was developed in response to the request of a wire producer.

It is designed to give lustre to dull coated wire without damage to the coating. Efforts to brighten the wire by drawing through dies inevitably resulted in some loss of coating. This loss is avoided by the rolling action of the two-pass mill. The two roll stands are at 90-deg. angles to each other to insure planishing of the full surface of the wire. Motive power is applied through the winder. The unit is built to keep pace with one wire production line, the wire coming from the coating bath in rough coils, being set on reels, then drawn through the mill and rewound into finished coils. The total weight of the unit is about 1600 lbs.

Company engineers report that the design can be adapted to provide a sizing mill at the end of a rod mill roll train.

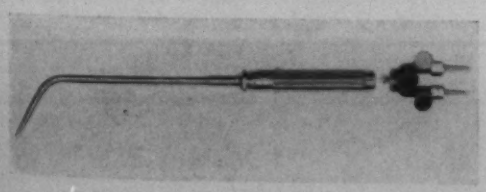


Welding and Cutting Equipment

A number of improvements are featured in the new line of Prest-O-Weld welding and cutting apparatus, recently introduced by The Linde Air Products Co., 30 E. 42nd St., New York, after extensive field tests. This new equipment consists of a welding blowpipe, cutting blowpipe, and cutting attachment. All retain the detachable valve body construction, exclusive with Prest-O-Weld equipment, which permits quick changing from welding to cutting, and cutting to welding.

Among principal features of the W-108 welding blowpipe (illustrated) are the individual mixers in every head, making correct flame adjustment easy and giving definite resistance to flashback. Both the oxygen and acetylene for this "balanced-pressure" blowpipe may be set at approximately the same pressure in lb. per sq. in. as the number of the head. The welding heads are described as providing a long, slender flame wtih a well-formed inner cone that permits thorough heating of even the bottom of the vee, and provides good control of the welding puddle. Special heads that confine the flame to a small area are available for welding auto fenders and similar work.

The new C-108 cutting blowpipe and the CW-108 cutting attachment are also constructed on improved design principles. A lower preheat oxygen pressure permits a large flame for cutting very dirty or heavily scaled material. Like the welding blowpipe, they have improved flashback resistance, are strongly built and are well-balanced for ease of handling. This apparatus is available separately or in combination outfits. In addition, since the new blowpipe handles can be used with detachable valve bodies already in use, owners of Prest-O-Weld apparatus can take advantage of these improved design principles very economically.



A Machinability Slide Rule

A stainless steel machinability "slide rule" incorporating the condensed findings of 2 yrs. of intensive research on the machining of stainless steel, has been produced by Rustless Iron & Steel Corp., Baltimore, Md., here for men and firms engaged in fabricating the metal.

The research program was carried on by a force of machinists and metallurgists, and covered the turning, forming, threading, drilling, tapping and reaming of stainless steels. Thousands of samples were machined at various speeds, and with various types of tools.

By setting the slide on the chart to the type of stainless steel to be machined, data on speeds, feeds, and cuts may be read directly. The reverse of the chart carries suggestions as to tool design, grinding and coolants.

Tubular Lead Anode for Chromium Plating

A tubular design of lead plating anode, stated to give unusually even throwing power and low resistance for the current discharge surface available, is being manufactured by Acme Lead-Burning Co., 3725 West 73rd St., Cleveland. It may be supplied either in pure lead or in 6% antimonial, as may be specified. This type of anode is particularly recommended for the center anode busbars of a tank, because of the equal current-distribution on all sides. For the anodes of the side busbars a semicircular pattern is recommended; or the ordinary flat anodes may be employed. It is claimed that, because of the simple design and the smaller amount of lead needed, these tubular anodes cost less than the regular flat ones.

FROM ORE TO METAL

The Story of St. Joe Electro-Thermic Zinc No. 10 of a Series

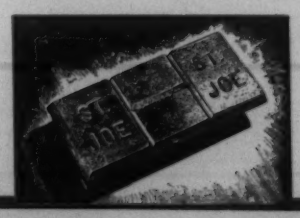
"Tapping the Condenser"

METHOD OF CONDENSING ST. JOE ELECTRO-THERMIC ZINC

The Josephtown continuous condenser is a unique metallurgical development permitting the condensation of large volumes of zinc vapor into metal. Incoming gases from the electro-thermic furnace are bubbled through a bath of molten zinc. The effect is similar to that of a jet condenser

The condenser is in the shape of a huge U-tube with one arm, the outgoing branch, slanting upward at an angle of 30° from the horizontal. Vacuum applied to the outgoing branch displaces the bath so that a bubble of gas is drawn down the incoming branch and around the bend. The bubble then rushes up the outgoing branch, where it slightly releases the vacuum, allowing the metal to fall back. This constant sloshing back and forth of the metal bath efficiently scrubs the gas and condenses the metal vapor.

The overall length of the condenser is about 14 feet. The metal bath carries 12 tons, and about 15 tons of zinc is produced by each condenser during 24 hours of operation. Periodically, 1500 pounds of high purity molten zinc is tapped from the condenser, carefully sampled, and cast into slabs of St. Joe electro-thermic zinc.



ST. JOSEPH LEAD COMPANY

250 PARK AVENUE • NEW YORK

ELdorado 5-3200

PLANT AND LABORATORY, JOSEPHTOWN, BEAVER COUNTY, PENNSYLVANIA

Electric Furnace Employing Ammogas

Damage to tool steels by oxidation, decarburization, distortion or cracking during hardening is claimed eliminated through a new refinement of hardening methods, utilizing a new electric furnace, developed by Westinghouse Electric & Mfg. Co., E. Pittsburgh.

An Ammogas atmosphere, so inactive with carbon that a soft skin does not form on 1.5 per cent steel soaked in it at 1850 deg. F. for an hour, is said to be the key to the furnace's success. Its composition needs no adjustment to the requirements of the steel being hardened, and its strongly reducing character aids in the hardening of stainless steel without tarnish. The furnace is tilted at an angle of 20 deg., with the entrance at the low end. As Ammogas is lighter than air, this prevents contamination of the pure gas atmosphere in the furnace even with the entrance open. Special radiation shields hold and keep the heat uniform.

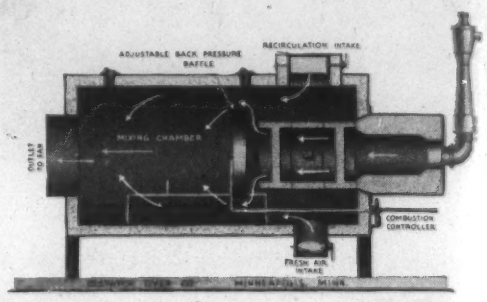
Operation of the oven is described as simple and foolproof, easily done by anyone familiar with heat treatment. Pre-heating of work is unnecessary, and cooling is accomplished faster in the gas atmosphere than in air. Out of 350 tests, not one steel die or tool was spoiled. From 1 to 3 hrs. is required for heat treatment, varying with the type of work, and thus hardened, a tool or die is said to have a bright, clean surface as hard as the underlying metal. Carburizing power of Ammogas can be controlled without changing the reducing power. The gas does not change composition in the furnace, and its inexpensiveness allows a constant circulation through the furnace to hold out impurities.

Direct Fired Air Heater

The Despatch Oven Co., Minneapolis, Minn., has brought out a "New Despatch Direct Gas Fired Externally Mounted Air Heater" which is described as employing a novel "controlled combustion" feature, which takes the "stink" out of convected air heating. These new heaters are said to combine high operating efficiency and flexibility with durability, safety and simplicity into a compact practical unit that is simple to install and easy to operate. They are recommended for all heating operations from 100 to 1250 deg. F. where the products of combustion are not objectionable and where convection heating is required to give the best possible results.

Some of the advantages or features claimed for the Despatch Air Heater include: (1) Easy to install, operate and maintain; (2) safe operation; (3) operating flexibility; (4) savings on the original investment; (5) cleanliness.

Controlled combustion is claimed a novel feature found only on Despatch Direct Fired Air Heaters. It is described as a new development, assuring greater operating efficiency and flexibility under all kinds of heater applications. The need for an adjustable controlled combustion feature on externally mounted direct fired air heaters has been long apparent. It is claimed that this new Despatch controlled combustion feature is saving users thousands of dollars yearly by lowering gas costs, eliminating rejects and improving utility.

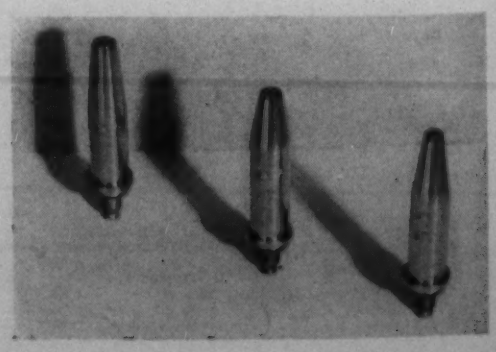


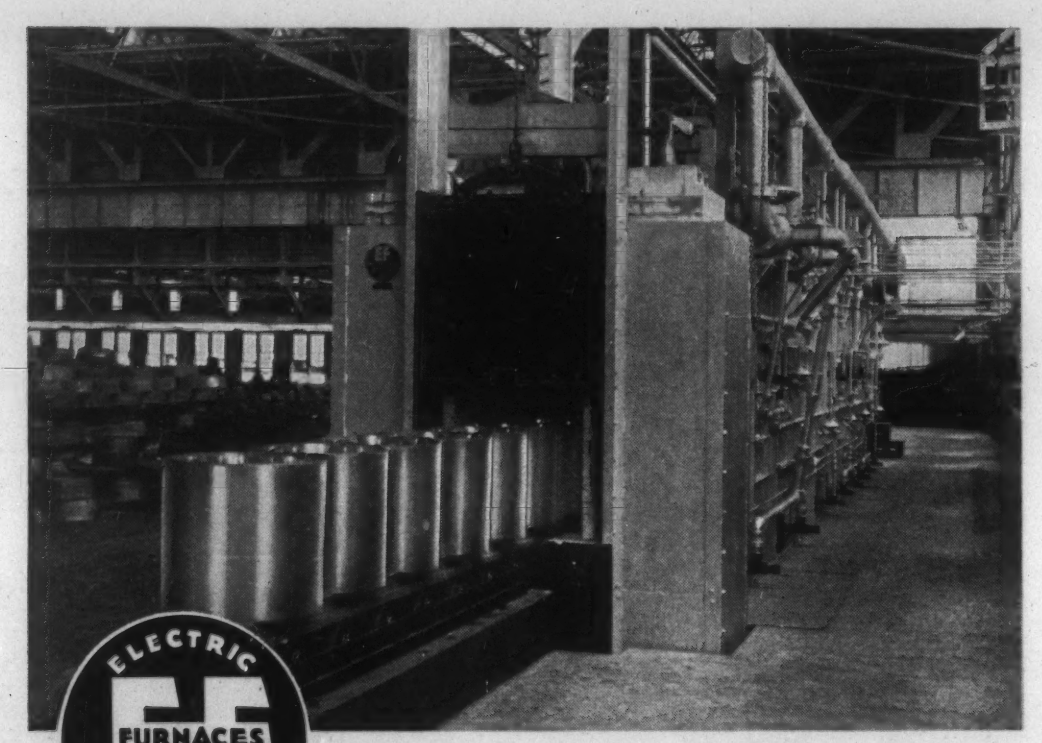
Oxweld Nozzles

Operators of oxy-acetylene cutting machines are notified that new, precision cutting nozzles are now available which make cuts of such exceptional quality that usually no subsequent machining is required.

The new Oxweld nozzles are claimed superior to regular cutting nozzles for three reasons. First, the cutting oxygen passage is highly polished, thus producing a smooth gas flow without deflection or turbulence, resulting in a clean, unbelievably smooth face of cut. Second, the preheat holes are smaller and spread over a larger circle so that the heat is less concentrated on the line of cut, resulting in a squarer, cleaner, sharper upper edge, a smaller kerf, and a saving in preheat gases. Third, the cutting oxygen passage is exactly vertical when the blowpipe is vertical, so that when cutting shapes or circles, the face of the cut is exactly true all around.

Of particular importance, too, is the fact that the new nozzles make it easy for the average operator to obtain consistently good cuts day in and day out, it is claimed. Further information about the new nozzles can be obtained from the nearest office of The Linde Air Products Co., 30 E. 42nd St., New York.





ELECTRIC EF FURNACES FUEL FIRED

Another EF Gas Fired Installation . . .

For Annealing Strip in Coils

Strip—ferrous and non-ferrous—both coiled and in strands—is uniformly annealed in various types of continuous, semi-continuous and batch type, electric and fuel fired furnaces we have built. The above gas fired installation is one of several roller rail, conveyor type furnaces we recently installed in a prominent eastern plant, for annealing large coils of both narrow and wide strip.

These furnaces can be built for any size coils or for any production required.

Send for leaflets showing other installations.

Other E.F. installations include controlled atmosphere furnaces for bright and clean annealing various ferrous and non-ferrous products including wire, tubing, strip, sheet, stampings and other products—furnaces for copper brazing, scale-free heat treating and annealing without scale or decarburization as well as furnaces of various types for normalizing, short cycle malleableizing, nitriding, carburizing, enameling, billet heating, heating for forging and other processes.

Submit your furnace problems to E.F. Engineers.

We build furnaces for any process, product or production.

The ELECTRIC FURNACE Co.

ELECTRIC & FUEL FIRED *Furnaces*

SALEM, OHIO

Current Metallurgical Abstracts

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DECEMBER, 1939

1. Ore Concentration

Crushing, Grinding, Plant Handling, Gravity, Concentration, Flotation, Magnetic Separation, Amalgamation, Cyanidation and Leaching.

2. Reduction

Blast Furnace Practice, Smelting and Electro-refining.—Ferrous (2a), Non-Ferrous (2b).

3. Melting, Refining and Casting

Open-Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces. Foundry Practice, Equipment and Materials. Die Casting.—Ferrous (3a), Non-Ferrous (3b).

4. Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.—Ferrous (4a), Non-Ferrous (4b).

5. Heat Treatment and Heating

Aging, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Normalizing, Surface-Hardening and Tempering. Furnaces, Soaking Pits, Refractories, Atmospheres, Fuels and Auxiliaries.—Ferrous (5a), Non-Ferrous (5b).

6. Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering.—Ferrous (6a), Non-Ferrous (6b).

7. Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, "Oxidizing" and Non-Metallic Finishing.—Electrolytic Methods (7a), Non-Electrolytic Methods (7b).

8. Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.—Fatigue Testing (8a).

9. Metallography

Structure and Constitution. Metallographic Equipment.—Ferrous (9a), Non-Ferrous (9b).

10. Properties and Applications

Including Relation of Properties to Engineering or Product Design.—Ferrous (10a), Non-Ferrous (10b), Effect of Temperature (10c).

11. Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation. Abrasion, Cavitation and Erosion.

12. General

General Metallurgical Engineering, Powder Metallurgy, Economics, History, etc.

2 Reduction

Blast Furnace Practice, Smelting and Electro-refining

EDWIN F. CONE, SECTION EDITOR

2a. Ferrous

German Process for Working Low-grade Iron Ore. It has frequently been stated that Germany's wartime iron and steel requirements can never be adequately supplied from workable ore supplies available to her, particularly in the face of an effective blockade. Nevertheless, the Germans do have a large supply of low-grade ore, which their ingenuity may succeed in exploiting on an emergency basis, whatever the cost, to cover her needs even for the duration of a long war. One of the methods now in use is the Krupp direct-iron process, described in German publications in 1934 (see *Metals and Alloys,* Vol. 6, Jan. 1935, p. MA2R/9). Practical experience with the process is reviewed in a group of articles in a recent issue of *Tech. Mitt. Krupp, Forsch. Ber.*

The technical factors are discussed by F. JOHANNSEN ("Das Krupp-Rennverfahren," *Tech. Mitt. Krupp, Forsch. Ber.,* Vol. 2, Sept. 1939, pp. 146-162). The process is particularly suitable for the reduction of low-grade Fe ore containing large amounts of S, P and SiO_2. Ore broken down to 5-8 mm. pieces is mixed with coke breeze or powdered coal and fed continuously to a rotary furnace at 600°-1100° C. where it is reduced to a low-C (0.5-1.5% C) sponge, which emerges from the exit end of the furnace as pasty blooms from which the slag is immediately squeezed out. Some of the advantages (from the German viewpoint) over blast furnace practice for the same ore are the reduced importance of slag temperature, the adaptability to high-ash fuels and the lower cost. Iron recovery is 90-96%; P remains in the blooms, most of the Mn goes to the slag as oxide, and S may vary in the product from 0.02 to 1.1%, depending on slag basicity. Relatively high-grade material may be charged directly into the steel-making furnace, but the usual concentrates from low-Fe, high SiO_2 are best re-treated in the blast furnace.

Operating data on practice at Krupp's Essen-Borbeck works, handling ore of 25-40% Fe and 15-32% SiO_2, are given by H. LEHMKÜHLER ("Die Verarbeitung eisenarmer, saurer Erze nach dem Krupp-Rennverfahren in der Betriebsanlage der Fried Krupp-A.G. zu Essen Borbeck," *Ibid,* pp. 154-162.) A comparison of the Krupp direct-iron process and ordinary blast furnace practice, from the economic standpoint, is made by H. BANSEN ("Die stoff-, energie- und betriebswirtschaftliche Einordnung des Rennverfahrens," *Ibid,* pp. 139-145). The production cost comparison becomes increasingly unfavorable to the blast furnace as the SiO_2/Fe ratio in the ore increases. For low-grade German ore the Krupp process is said to mean a much greater economy in fuel, labor and capital investment. Ha (2a)

2b. Non-Ferrous

Production of Magnesium. L. M. PIDGEON (National Research Council) *Can. Chem. Proc. Inds.,* Vol. 23, Aug. 1939, pp. 395-400. New methods directed toward utilization of Canadian raw materials are outlined. Brucite is of prime importance if the electrolytic method must be employed. Other available raw materials that might be used are magnesite, dolomite, serpentine and magnesia from sea water. Methods, in addition to the electrolytic process, are direct reduction, reduction by C, by Si, and by calcium carbide. Experimental work is outlined on the electrolytic and electrothermic methods as conducted at the National Research Laboratories. WHB (2b)

3 Melting, Refining and Casting

Open Hearth, Bessemer, Arc, Induction, etc. Melting Practice and Furnaces, Foundry Practice, Equipment and Materials. Die Casting. For Refractories, see Section 5

C. H. HERTY, and G. L. CRAIG, SECTION EDITORS

Correct Venting Eliminates Waste (Richtige Luftabfuhrung verhindert Ausschuss) FR. NAUMANN. *Giessereipraxis,* Vol. 60, July 30, 1939, pp. 325-330; Aug. 27, 1939, pp. 353-356; Sept. 24, 1939, pp. 392-395. Practical. Extensively discusses the many points to be observed in mold venting to obtain sound castings. The practice of venting underneath the closed flask briefly before casting is characterized as a grave mistake. The amount of the vent holes necessary entirely depends on the size of the casting and the molding sand used. Special precautions are required in venting large castings; the vents must be arranged in layers. Covering of risers before casting is stressed. Cases are discussed where special air-relief risers must be applied to avoid so-called air cushions. Air pipes must be used in large numbers to process castings of highest quality. With large thin-walled castings it is necessary to relieve the gases within the flask partition. Upon fitting several molds into each other the gas escape between the individual molds must be adequately taken care of. The most important, but not always the simplest place to utilize venting is in the cores within the mold. GN (3)

3a. Ferrous

The Effect of Titanium on the Macrostructure and Grain Coarsening Temperature of Forging Steel. GEORGE F. COMSTOCK (Titanium Alloy Mfg. Co.) *Preprint, Am. Soc. Metals,* Oct. 939, 11 pp. Research. Small ingots of steel containing 0.32-0.41% C, 0.62-0.72% Mn, 0.10-0.37% Si, and low P and S, were poured at controlled temperatures between 2900° and 2950° F. from industion furnace melts to which Al, Al plus Ti, or Al plus Zr, were added in various amounts just before pouring. The ingots were split lengthwise, ½ of each being etched by Humfrey's method to show the macrostructure, while the other half was forged to a 1-in. square bar. Samples from this bar were heated for 8 hrs. at selected temperatures from 1700° to 1950° F., and the grain sizes were determined after heating.

Residual Ti contents of about 0.1% or more were found to prevent the formation of coarse dendrites in these ingots, while with similar amounts of Al or Zr, but no Ti, coarse dendrites were formed. With Ti contents above 0.2% and Al additions of 0.05-0.15%, the grain coarsening temperature of this steel was found to be above 1950° F.; and Ti contents of 0.10-0.12% with Al additions of 0.05-0.15% gave higher grain coarsening temperatures than were obtained with about 0.1% Zr or by increasing the Al addition alone from 0.10 to 0.15%. For the elimination of coarse dendrites, or raising the grain coarsening temperature, definite residual Ti contents in the steel are necessary and not mere deoxidation with Ti. Preliminary deoxidation with Al helps to retain the required Ti in the steel. (3a)

Corrosion of the Cupola Refractory Lining (Le Mécanisme de la Corrosion des Revêtements Réfractaires dans le Cubilot) YVES LETORT. *Bull. Assoc. Tech. Fonderie,* Nos. 6-7, June-July, 1939. Pp. 248-257. Research. The following corrosive materials were investigated: the slag removed from the cupola; mixture of limestone and coke ashes; mixture of limestone, coke ashes and iron oxide. Experiments were carried out with pure silica bricks, alumina bricks with different ranges of alumina content (30 to 42%, 60% and about 90% of alumina), magnesia and chrome-magnesia material, and silica lining containing about 90-92% of silica. The specimens, in the shape of cubes, were cut from the bricks or molded of the lining material investigated. In these specimens cylindrical holes 25 mm. in diameter and 25 mm. deep were drilled and the corrosive materials were inserted therein. The covers used were of the same refractory material of which the specimens were made. The temperature adopted for these tests was 1600° C., and the time at temperature 1 hr. The cubes were then sectioned along the diagonal plane and also cut in half. The sections were photographed and the change in the inside area of the crucible was measured either planimetrically or geometrically. These photographs produced information relative to the mode of attack of the refractory material by different corrosive agents. Microscopic examination of the corrosion products under polarized light proved to be of great value. Magnesia lining showed exceptionally high resistance to corrosion. The resistance of the silica lining was not uniform, although some specimens withstood the corrosion test very well. Certain alumina linings also showed an improvement depending upon their chemical nature and the process by which they were constructed.
AIK (3a)

Producing a Large Iron Casting by the Randupson Process. G. LONGDEN. *Foundry Trade J.,* Vol. 61, Sept. 7, 1939, pp. 169-170. Descriptive. Numerous advantages are claimed for the cement-mold process for producing iron castings. Of primary importance is the high quality of the casting, which can be attributed to the high resistance of the cement-sand structure to the molten metal. The metal can be poured at a high temperature without danger of scabbing or washing. Blowholes are not entirely eliminated, but they are not so pronounced with cement-bonded sand as in other molding sand. Gas is practically eliminated because of the inert nature of cement bond, but any gas generated has free escape through the walls of the mold. The process, first exploited in France, is based on the principle of using molds made from silica sand and cement, with water added. The mixture has a consistency similar to sand used for oil-sand cores. The sand is pushed rather than rammed round the pattern by means of plungers. Instead of iron flasks, wooden frames are used, which are removed immediately after the pattern has been withdrawn. There is no artificial drying of cement-bonded molds; small molds are allowed to dry under atmospheric conditions 48 hrs., and large ones 72 hrs. Construction of mold for casting, required for Slipway Haulage, measuring 11 ft. 6 in. long (including 1 ft. 6 in. head metal) and 7 ft. 8 in. long inside diam., and weighing 20.5 tons, is described. The temperature of the metal taken in the runner box was 1150° C. and the analysis was: T.C. 3.45; Si, 1.65; Mn, 0.56; S, 0.089 and P, 0.73%. Tensile strength was 30,000 lbs./in.^{2}, transverse (bar 1.2 diam. by 21 in. broken on 18 in. centers) 2628 lbs., and deflection, 0.24 in.
AIK (3a)

The Influence of Temperature on the Carbon-oxygen Equilibrium in Molten Steel (Om temperaturens inverkan på jämvikten mellan kol och syre i smält stål och i en gasfas) G. PHRAGMEN & B. KALLING. *Jernkontorets Ann.,* Vol. 123, No. 5, 1939, pp. 199-221. Research. The equilibrium was measured experimentally in a high frequency vacuum oven using 400 g. molten iron in a crucible of MgO or Al_2O_3. Carbon was added in amounts slightly above or below the expected equilibrium values. Analyzed mixtures of CO and CO_2 were passed over the mass. Experiments were run at 1550° and 1700° C. measured by optical pyrometer. After exposure for 2-4 hrs. the reaction mass was cooled and analyzed. The original sample had the composition 0.027% C, 0.07% Mn, 0.014% S, and 0.01% P. At 1550° C. the equilibrium values were 0.07% C with 2.5% CO_2, 0.035% C with 5% CO_2, and 2.02% C with 7.5% CO_2. At 1700° C. the values were 0.07% C with 1.7% CO_2, 0.03% C with 3.4%CO_2, and 0.02% C with 5% CO_2. Phase rule diagrams have been constructed for the system on the basis of the above results.
HCD (3a)

Metallurgical Reactions in Recuperative Steel Melting Furnaces (Das metallurgische Reaktionsgeschehen im Rekuperativ-Stahlschmelzofen) M. BURCHARDT & M. PASCHKE. *Stahl u. Eisen,* Vol. 59, May 11, 1939, pp. 565-572. Practical. Describes the operation of an open-hearth furnace equipped with recuperator stoves made of heat resisting steel. The furnace has now melted 18,500 tons of steel with good results. Detailed heat logs of 6 heats are given showing analyses of the bath and slag, and temperature of the bath, during the progress of the heats. SE (3a)

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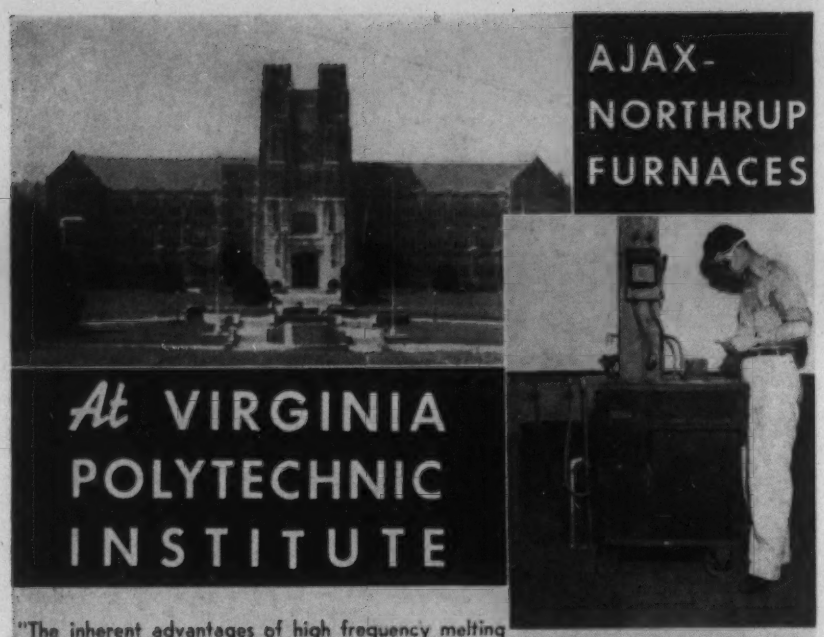

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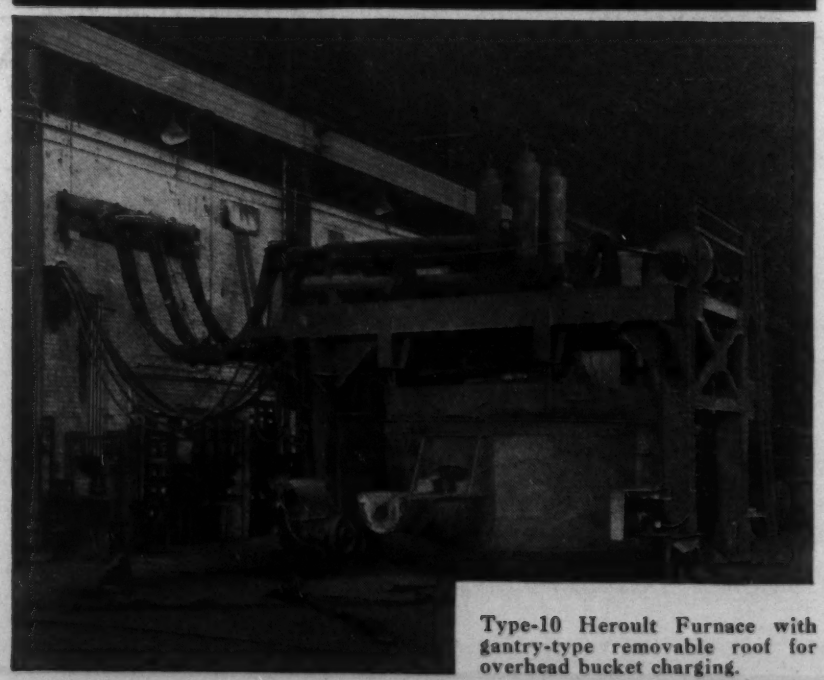

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3b. Non-Ferrous

Non-ferrous Foundry Practice, XXVI-XXIX (Aluminum and Magnesium Alloys) J. LAING & R. T. ROLFE. *Metal Ind., London,* Vol. 55, July 14, 1939, pp. 27-32; July 28, 1939, pp. 75-79; Aug. 25, 1939, pp. 169-172; Sept. 1, 1939, pp. 205-208. Practical. Aluminum founding differs somewhat from brass. Green sand is almost universally used. The molds are rammed more lightly, as the light alloys are susceptible to blowing if molds are rammed too hard. With properly-rammed molds venting is unnecessary. Common defects that can be reduced by correct gating include air bubbles, drawn regions and cracks. Incorrect gating in Al alloys may decrease the strength much more than in other metals. With Mg in the alloy the tendency to form dross increases with Mg content and skim-gates are advantageously used. Greater use is made of risers with aluminum than with brass. To feed effectively, risers must be large enough to remain liquid until after the casting immediately below has solidified. Heavy risers may cause cracking in the adjacent thin section. Chills are often used to prevent draws and sinks on heavy sections and on machined surfaces, which must be free of pin-holes. Although commonly employed, chills should be avoided because of the stresses they cause, and because of the attendant condensation of moisture. Pouring temperatures are of paramount importance. Theoretically, each casting should be poured at the lowest temperature to fill the mold but this cannot be readily accomplished in practice. Most Al alloys are poured at about 700° C. In the Si-Al group the pouring temperature is governed by the "modification," and is about 760° C.

The principal defects to which aluminum castings may be subject are: Dross inclusions, drawn and porous regions, blowholes and cracks. Dross inclusions are due to poor skimming. Drawn regions are caused by insufficient feeding. Intercrystalline cavities are usually associated with large grains resulting from slow cooling, while pinholes are ascribed to absorbed gas. Blowholes are caused by wet sand, hard ramming, poorly vented cores, cold metal or incorrectly placed gates. Cracks are associated with continuous large and thin sections. In melting aluminum the flame must not contact the metal, and only a minimum superheat should be used. Stewing should be avoided. Copper is added as a 50/50 Cu/Al alloy, and most of the other elements are added alone.

With proper procedure Mg alloys have good castability and are particularly free from pinholing and other types of unsoundness caused by the disengagement of gas during solidification. The advantages of Mg alloys considerably outweigh the disadvantages. Industrial alloys are confined almost exclusively to those containing 3.5-12% Al with Zn up to 3.5%. Aluminum and Zn are added chiefly to increase the strength. Manganese between 0.5 and 2.5% has little influence on the mechanical properties, but is added specifically to improve the corrosion resistance. Cadmium increases the tensile strength slightly, and alloys containing Cd are used chiefly in the wrought state. Silver is little used in cast Mg alloys, but it does improve the ulitmate stress of wrought alloys at temperatures up to 200° C. Tin is rarely used in Mg alloys; as a hardening and strengthening constituent it is inferior to Al or Zn. Lead finds no application. Copper, although a hardening constituent, is damaging to corrosion resistance and is not ordinarily used. Nickel similarly impairs corrosion resistance. Silicon is considered to cause greater unsoundness in castings, and therefore limited to 0.4-0.5%. Small amounts of Fe can be disregarded. Of the other additions, the most promising is an alloy of 10% Ce, 1.5% Co and 1.5% Mn. The increase of solubility of Al in Mg with temperature renders the alloys responsive to age hardening in the usual manner. For molding a highly permeable silica-sand is used, bonded with about 5% of a colloidal clay and containing about 5% water. Gating practice is much the same as with high-strength Al alloys. Chills are used extensively, particularly on pressure castings. The metal is melted in low-C cast steel pots with large amounts of a very fluid flux. Zinc and Al alloy readily with Mg and can be added direct. Manganese is added in the form of a Mn-Al hardener. The suitable casting temperature is 100° C. above that at which the alloy is completely molten. For Part XXV see *Metals and Alloys,* Vol. 10, October, 1939, p. MA 583 L/2. RWB (3b)

Production of Light Metal Die Castings (Herstellen von Leichtmetall-Spritzgussteilen) W. MÜLLER. *Maschinenbau Betrieb,* Vol. 18, Aug. 1939, pp. 375-378. Practical. The different shrinkage of the various alloys must be carefully considered in designing for die casting. The shrinkage forces of Sn and Pb alloys are so small that cores, etc., can be made without draft, but the shrinking has to be included in the calculations on the dimensions. With these heavy metals, good flowing properties and low bath temp. of 300° C. permit the use of free-standing walls of 0.016 to 0.032 in. and free-standing cores down to 0.02 in. diam.

without bending. When using Zn die casting alloys difficulties increase on account of the higher bath temp. (405° C.) and the higher pressure required. The shrinking forces are such that draft on die parts that are all surrounded by metal must be provided. For Al alloys with temperature of 620° to 700° C. the requirements on dies are, of course, even more severe. The tendency of these alloys to seize makes a more liberal draft necessary. For higher numbers of shots the die parts have to be hardened. This hardening operation introduces distortion and thus impairs the accuracy obtainable. The bath temperature for Mg alloys is 650° to 720° C., viscosity is about the same as Al alloys; the heat content lower, which means more rapid solidification. Magnesium alloys do not attack die parts so that hardening is not always necessary. Thus the same close tolerances as in Zn die casting are obtainable. Magnesium alloys are rather hot brittle so that the tendency to cracking upon ejection exists. Some principles concerning accuracy and avoiding of subsequent machining are outlined. RPS (3b)

4 Working

Forging, Rolling, Drawing, Extruding, Punching, Stamping, Shearing and Machining.

S. EPSTEIN, A. W. DEMMLER

AND H. W. GRAHAM,

SECTION EDITORS

Direct Rolling of Metal. C. W. HAZELETT (Hazelett Metals, Inc.) *Mech. Eng.*, Vol. 61, Nov. 1939, pp. 823-824. Descriptive. The present status of the production of strip metal of high melting point directly from molten metal (i.e. without first casting into ingots) is discussed; only the Hazelett process for direct rolling is considered. One of the author's first machines, developed in 1921 to produce continuous strips of antimonial lead for storage battery grids is said to be still in commercial operation; this was a single cooled drum with a spaced, stationary copper shoe through which the metal was poured. A subsequently developed double-horizontal-roll casting machine was found technically satisfactory for direct rolling of lead, tin and their alloys. A few years ago, at Scovill Mfg. Co., "substantial" tonnages of brass strip, 12-in. wide of good physical properties and weighing up to 3,000 lbs., were produced; segregation stains, however, interfered with the salability of the product for certain purposes. The same difficulty was encountered in attempts at Crown Cork & Seal Co. to commercialize the production of Cu-bearing aluminum strip by this method.

Segregation resulted because of irregularities in cooling, caused by the fact that the frozen film travelled at a different speed than that of a point on the roll, hence "folded," while the lower melting constituents were forced under pressure into the places of least cooling and lowest pressure. Recently the American Metal Co. and Scovill, working together, have applied a system of controlled atmospheres to the Hazelett process to produce OFHC Cu strip, which, being a pure metal, would not be subject to segregation. The summarized accomplishments of the process to date comprise the production of long strips of sound metal, straight, flat and adequately accurate as to gage, up to 24 in. wide, at low cost and with commercial roll life. Substantial tonnages of satisfactory steel strip, 24 in. wide have been rolled by Crown Cork & Seal. International Nickel has rolled nickel and Monel strip by this process. For these high-melting metals, however, roll life was hopelessly short to permit of competition with conventional processes.

The segregation and folding problems are being attacked by pouring the molten metal on the outside and on the inside of a previously de-gassed cylindrical surface, to permit almost complete chilling, and then subjecting the metal to surface-rolling to chill and compress the very small film of unsolidified metal. The necessary high rates of cooling of the cylindrical surfaces are said to have been achieved. The production of thinner strip is now possible by the use of high speeds and short contact between molten metal and cooling surface. Thus, 0.025-in. strip is produced at 500 ft./min. with a contact of 2 in., or in an elapsed time of 1/50 sec.

The present and most successful cooling surface is a ring of strip steel, driven between 2 small rolls; the molten metal poured on the ring (which may be 20 ft. in diameter, if desired, for maximum cooling surface) gives up most of its heat of fusion thereto. For an upper roll, to surface-roll the product, internally water-cooled rolls 2½ in. in diameter with extremely thin (⅛-in.) walls are used, which will run continuously at these high speeds without heating up, if enough water is forced through them; roll pressures of only a few hundred lbs./in.^{2} are required. So far, most work with the new design has been on brass, but experimental runs on copper, aluminum, low-C steel, and Si-steel indicate that the good results on brass—absence of stains, segregation and folding, applicability for gages down to 0.015 in., use of commercially desirable speeds, and negligible roll cost per ton of product—can be similarly attained on the other metals. FPP (E-4)

Tools for Deep Drawing and Pressing. Part II. Tool Material. J. D. JEVONS. *Metal Ind., London,* Vol. 55, Sept. 8, 1939, pp. 217-220; Oct. 6, 1939, pp. 309-313. Practical. Prior to recent developments in special cast iron, steel was the generally accepted die material. Plain-C steels as die materials are classified as 0.7-0.9% C which is selected for large tools, and 1.0-1.2% C which is very popular for dies. The virtue of high-C water hardening steels is the very high surface hardness which engenders high resistance to attrition, scoring and fouling. Low-C alloy steels (0.3-0.5% C, 1-3%Ni, or 0.5-1.5% Cr, 0.25% Mo) are not used extensively for dies, except for light draws. The most popular of the high-C alloy steels are the W and Cr steels (0.7% C, 0.5-0.8% W or 1.1%C, 1.2% Cr, 1.2% W). The high-C high-Cr steels are popular as drawing dies. The high-C low-Cr steels (1.0% C, 1.0% Cr) are now coming into use. Case-hardening steels (carburizing or nitriding) of several types may be used. For punches a steel of 0.3% C, 1.5% Ni, 1.0% Cr and 0.25% Mo, carburized, gives excellent results. The extreme hardness of the nitrided surface is the principal attribute of nitriding steel. Owing to dressing difficulties, it is seldom worth while to recondition nitrided tools. Graphitic steel (1.5-1.25% C) is not commonly used for tool material, but recently attention has been focused in this direction and it may become a formidable rival to inoculated cast iron for drawing dies. The steel cost is higher, but it can be forged and rolled while iron cannot be so worked. The steel also possesses high impact strength and can be safely hardened to 60 Rockwell C. The use of Cr-plate is acknowledged as feasible, but discussed only from the angle of the steel used, especially from the standpoint of using too expensive a steel when Cr-plating.

Many users consider cast iron the most valuable of any commonly used tool material. For tool use, cast iron may be divided in three classes: Unalloyed, alloyed, and inoculated. Although important, plain gray cast iron has been quite overshadowed by the recent development of special varieties of cast iron. Gray iron is the cheapest tool material, has good durability, and can be cast closely to shape, but if heavily loaded it wears rapidly, and there is danger of unsound areas showing up. Cast iron properties are commonly improved by Ni and Cr additions, which produce greater durability, closer texture, greater hardness and soundness. The distinguishing feature of inoculated iron is the fine uniform dispersion of the graphite flakes, which increases the strength, toughness, soundness and uniformity, and renders hardening by quenching more beneficial. RWB (D-4)

4a. Ferrous

Increased Drawing Speed and Temperature in Drawing Steel Wire (Erhöhte Ziehgeschwindigkeit und Temperatur beim Ziehen von Stahldraht) FRITZ SCHWIER, FELTEN & GUILLAUME CARLSWERK. *Rundschau,* No. 25, May 1939, pp. 11-19. Original research. The results of drawing experiments on 3 different 4-mm. patented steel rods drawn at 5 different speeds from 0.45 to 1.65 m./sec., and with reductions of 11%, 20%, 30% and 35%,

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using soap as the lubricant, are considered, after an outline of the testing arrangement and mathematical considerations on power consumption in wire drawing in general. The steels had the following composition, in %:

	C	Mn	Si	P	S
1	0.06	0.30	...	0.012	0.03
2	0.40	0.55	0.16	0.03	0.03
3	0.60	0.55	0.16	0.02	0.03

Tensile strength, elongation, and reduction of area were determined, and bending and twisting tests were made. Increased drawing speed decreases the power consumption, or increases the deformation efficiency, about 6-7% with 11% reduction, 5-6% with 20% reduction, 5% with 30% reduction, and 4-5% with 35% reduction. The improvement of drawing efficiency with increasing speed increases simultaneously with the C content. The tensile strength increases with rising speed, at a rate depending on the C content. Elongation and bending number are not affected by the drawing speed, although the number of twists decreases with increasing speed.

The effect of the drawing temperature was studied at 13°, 40°, 70°, 100° and 130° C. with 3 different drawing speeds and 3 different reductions. Rape-seed oil was used as lubricant. With increasing drawing temperature the power consumption decreases, the more the larger the reduction. The previously noted decrease of power consumption at higher drawing speed, however, is not observed at drawing temperatures above 100° C. In comparison with drawing at room temperature, a higher tensile strength (reductions being equal) is apparent, and particularly with the higher-C steels. Correspondingly, elongation and reduction of area decrease while bending and twisting numbers decrease but slightly. All in all, steel rods, particularly of high-C steel, can be drawn at higher speed only within the limits of the desired tensile properties. Provided these properties are important only to a minor extent, increase of drawing speed and the consequent increase in temperature are not disadvantageous. GN (D-4a)

4b. Non-Ferrous

Experiments on the Mode of Deformation in the Deep Drawing of Shells of Various Profiles (Versuche über die Verformungen beim Tiefziehen von Hohlkörpern verschiedenen Querschnitts) H. UNCKEL. *Metallwirtshaft,* Vol. 18, June 30, 1939, pp. 567-576. Research. The deformation process in the drawing of round, oval and four cornered shells from brasses containing 72 and 62% Cu, and from aluminum, was studied. Drawing variables were thickness of sheet, initial blank diameter and various ratios of sheet thickness to drawing gap. To facilitate the study circles and radii or square nets were ruled on the disks. Small holes drilled perpendicular to the sheet were also used to follow the drawing process. Data consisting of measurements of thickness change and the change in distance between the coordinates of the inscribed net work are presented for the various alloys and shapes drawn. In general the conclusion is reached that for the three metals studied there existed no apparent differences in the mode of deformation except that the maximum inital diameter and maximum depth of draw varied from one alloy to another. GA (D-4b)

Properties of Zinc Alloy Sheets (Eigenschaften von Zinklegierungsblechen) KURT BAYER. *Z. Metallkunde,* Vol. 31, Aug. 1939, pp. 264-267. Original research. Binary Zn-Cu and Zn-Al, and ternary Zn-Cu-Al alloys with a maximum content of 6% Cu and 5% Al were cast into 15-mm. plates, hot-rolled between 180° and 250° C. and then cold rolled beginning at a sheet thickness of 3 mm. Samples were tested for tensile strength, elongation, bending and deep-drawing ability. The strength of Zn increases markedly with rising additions of Cu and Al, while elongation is hardly affected. The bendability of pure Zn is improved by 1% Al. The Al-bearing alloys show better bending properties than the Zn-Cu alloys (4-6% Cu) but the latter are superior in regard to deep-drawability. Additions of Al to Zn-Cu alloys scarcely affect the deep drawing properties unless the alloys are artificially aged. Magnesium increases the strength, but also the brittleness. Small additions of Ni, Na, and K entailed no essential changes of physical properties.

The alloys with 4-6% Cu were studied in particular detail. The direction of rolling was changed with some samples that showed lower strength but higher elongation values. Deep-drawing and bending values were considerably improved by changing the direction of rolling by 90°. As strip and larger sheets cannot be treated this way commercially, pre-pressing of the billets was used with some success. Zinc alloys with 4-5% Cu and 0.2-0.25% Al decrease in strength and increase in ductility with increasing amounts of plastic deformation. Some Cu-bearing Zn alloys increase in strength on annealing at 200° C. Comparative drawing tests on the 4% Cu-0.2% Al alloy, electrolytic Zn, brass and an Al-Mg alloy show a logical change of properties of the cubic materials, while the hexagonal Zn and its alloy showed inconsistent property changes in progressive deep drawing operations. The strength increases at first and then drops. Elongation is no indication of deep-drawability. The Zn alloys containing Cu and Al should be drawn at slow speed in the soft state, but faster if semi-hard. The experiments showed that Zn alloys with 4-5% Cu and 0.2-0.25% Al can be deep-drawn if special precautions in rolling and deep drawing are observed. EF (D-4b)

Working and Heat-treatment of Rods of Aluminum-copper-magnesium and Aluminum-magnesium-silicon Alloys (Einiges über Verformung und Warmbehandlung von Stangen aus Al-Cu-Mg und Al-Mg-Si-Legierungen) E. LAY & A. GRIMM. *Aluminium,* Vol. 21, Sept. 1939, pp. 627-637. Exhaustive investigation. The generally accepted rule is that in the manufacturing process the finest possible grain should be obtained, as then the anisotropic nature of the individual grain becomes of minor importance and the quasi-isotropic state determines the uniformity of deformation. With coarse grain the vectorial properties of the single grain are predominant, and scarry, uneven surfaces and lowered mechanical strength result. The investigations have now shown that excessive fineness of grain can also lead to mechanical difficulties in Al-Cu-Mg and Al-Mg-Si rods, just as it does in sheets. This occurs particularly in extruding processes, where deformation is often critical and very coarse recrystallization may then result, with marked reduction in tensile strength.

Normal values can be nearly restored later only by protracted heating at hardening temperatures; in such treatment the temperature of the quenching bath also has some influence, as the table shows:

Water temperature, deg. C.	Elastic limit, lbs./in.²	Tensile strength, lbs./in.²	Elongation, per cent
1.5	46,350	70,550	18.0
5.0	45,650	70,400	17.5
10.0	45,350	69,000	18.0
20.5	47,750	70,550	18.0
30.0	47,750	70,400	19.0
40.0	46,000	70,000	17.5
59.5	47,000	69,700	17.0
80.0	46,150	68,000	17.3
92.5	44,550	66,550	18.3

The highest mechanical strength is obtained in fully-hardened material by stretching, the higher the degree of stretching (rolling) the higher become elastic limit and tensile strength, with elongation only slightly reduced. Ha (D-4b)

Plastic Working of "Bunt" (Copper and Brass) and Light Metal Alloys in the Same Plant; Present State and Possible Developments in the Forming of Light Metals (Die spanlose Formung von Bunt- und Leichtmetallen im gleichen Betriebe; Stand und Entwicklungsmöglichkeiten der Formung von Leichtmetallen) OTTO EMICKE. *Z. Metallkunde,* Vol. 31, July 1939, pp. 217-228. Review plus original research. The application of fabrication equipment and procedure for "Buntmetalle" (copper and brass) to Al and Mg alloys was studied. Data on annealing, hot working temperatures, maximum deformations in cold and hot working, and thermal conductivities for steel, Cu-, Al- and Mg-base alloys are tabulated. The changes of physical properties of duralumin when rolled in various types of hot mills are shown. The special features of hot mills employed for the working of light metal alloys are discussed at length. The same wire mills can be used for both Cu-base and Al- or Mg-base alloys. When rolling copper first, the mill must be cleaned thoroughly otherwise local corrosion results on aluminum wire rolled afterwards. In drawing, the most suitable entrance angles are: Copper = 14°, aluminum = 7°. The latter must be drawn more slowly than the former. In cold rolling, the working conditions are greatly different for aluminum, copper and their alloys due to differences in rate of work hardening and initial strength. By exchange of rolls, the same mills may be used for all materials. The extrusion presses for light metals have been developed independently from those of Cu-base alloys. Magnesium alloys offer great difficulties in extrusion operations. A table shows the widely different pressures and temperatures applied in extruding copper, brass and Cu-Ni alloys on one hand, and Al and Mg alloys on the other. Applying some modifications, drop forging of both types of alloys can be executed in the same machines. EF (D-4b)

Notes on the Machining of Aluminum and Its Alloys. J. H. DICKIN & G. A. ANDERSON (British Aluminium Co.) *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 846. Practical. Because of the high speed and ease with which they may be machined, Al and Al-base alloys are often more economical than other materials. Pure Al machines satisfactorily, but, owing to its softness, attention must be paid to the design of tools and speed of cutting. With alloys, more normal tool shapes can be employed. Cast Al alloys have good machining properties, and, in general, the harder the alloy the better is the finish obtained. For this reason heat-treated alloys give very satisfactory results. Fine grain-size and freedom from pin holes are important factors.

For ordinary wrought-alloy machining stock, alloys containing Mg_2Si have replaced Cu-Zn-Al alloys, being capable of taking a fine finish at moderate cutting speeds. In automatics these alloys present a difficulty in that they are not free cutting. The curling of the chips causes them to foul the tools and renders their removal by means of the cooling medium almost impossible. Leaded brasses, and age-hardened Cu-Al alloys containing Pb are free-cutting, but, owing to segregation, the properties are not uniform and free-cutting is obtained at relatively low speeds. The addition of Sn to the Al alloys gives free-cutting properties, but there is difficulty in production because of hot-shortness. The addition of Sb with Sn eliminates the low-temperature liquid phase responsible for hot-shortness. For free-cutting, the addition of elements forming a separate phase is necessary, but this alone is insufficient, and the type of structure must be controlled. The question of tool shape and finish of tools is important in most machining operations. Lubrication is not critical, but low temperatures must be maintained. Soluble-oil emulsions help in obtaining low temperatures. JLG (G-4b)

Lathe Tests with a Cutting Liquid Preventing Burning of Chips (Zerspanbarkeits-Untersuchungen mit einer spänebrandverhütenden Schneidflüssigkeit) H. SCHALLBROCK. *Tech. Zentralbl. prakt. Metallbearb.,* Vol. 49, Sept. 1939, pp. 646-650. Original research. Experiments were made with a mineral oil (trade name: "Shell-Jumag") to prevent the ignition of Mg chips in the lathe. The oil was found to possess a measurable lubricating effect as determined by the reduction of the cutting force, and a considerable cooling effect as shown by a lower cutting temperature. In comparison with dry machining, the following observations were made when using the mineral oil: The surface quality of the machined part is improved; a more desirable type of chip is formed; the cutting forces are lowered only slightly, whereas other lubricants are much more effective; the cutting temperatures are lowered considerably; there is no corrosion attack after 240-hr. exposure of steel, Al-alloys and brass; the Mg alloys tarnish slightly (light gray) but during the relatively short time of contact in the lathe this effect was absent; on normal machining of light metal alloys no obnoxious fumes are generated, although at very high working speeds a white, ill-smelling fume occurs; in no case was ignition of the Mg chips noticed. The effect of the oil tested is comparable to the action of rape-seed oil. EF (G-4b)

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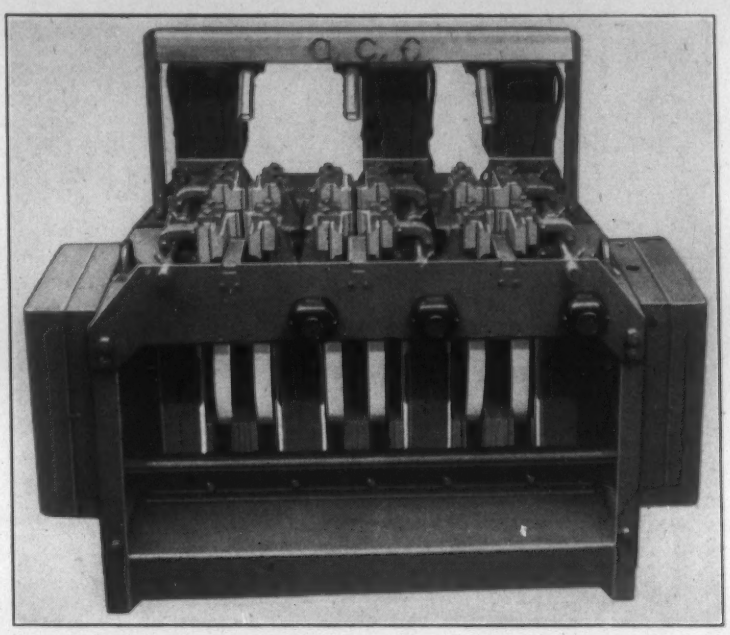

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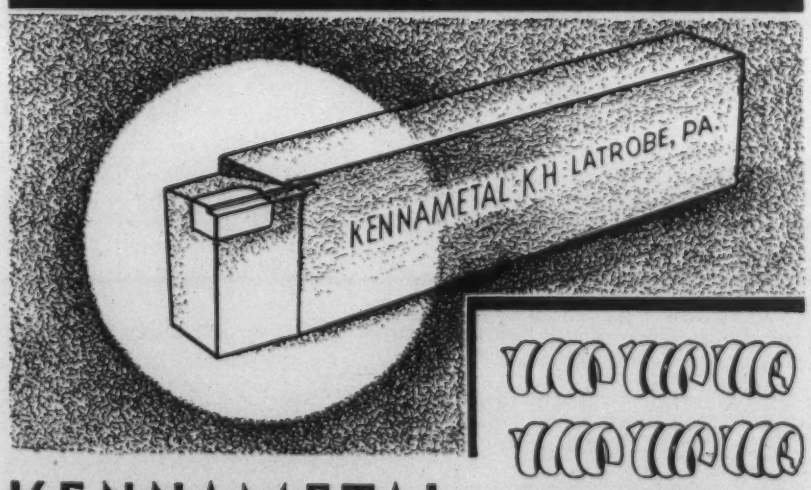

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SECTION EDITORS

Age-hardening. At its meeting in Oct. 1939, the Am. Soc. Metals conducted a symposium on age-hardening. As ZAY JEFFRIES expressed it in his excellent introductory paper ("Introduction to Precipitation-hardening," *Am. Soc. Metals,* Preprint 34, Oct. 1939, 7 pp.) "this art is so new, so important, so widespread, and so teeming with metallurgical life, that the factual high spots need to be inventoried. Again, so many views have been put forward—some inconsistent with others—in an effort to arrive at an adequate explanation of the phenomena involved, that an appraisal of the theoretical aspects should be welcome. These are but a means toward the achievement of the real goal, which is, to so stimulate present and future workers in this field that more and better precipitation-hardening alloys may be made available for the use of mankind." Hence the symposium. Jeffries reviewed Wilm's discovery of the "aging" of certain Al alloys; Merica, Waltenberg and Scott's explanation of age-hardening as the precipitation of an insoluble phase in the form of particles of critical size; nomenclature evolution (Jeffries waggishly suggests the ultimate use of the verb "to sol" in place of the awkward "to solution heat-treat" and "to cip" in place of "to precipitation-harden by heat treatment"); the extension of practical age-hardening to many other alloys than those of Al, and the search for and development of new age-hardening alloys; and some of the complex concepts currently involved in our consideration of age-hardening.

From the age-hardening standpoint, the most important alloys are those of aluminum. The technical and commercial aspects of their precipitation hardening are reviewed by L. W. KEMPF ("The Application of Solid Solution and Precipitation-hardening Effects in Aluminum Alloys", Preprint 35, 23 pp.). A precipitation-hardened alloy is usually less resistant to corrosion than the same alloy in the solid solution form, although this difference may be slight if the precipitate formed has an electrode potential close to that of the stable Al solid solution. Heat treating practice also effects corrosion resistance; at present empirical methods are used to develop proper practice, in any case, for the most satisfactory compromise between mechanical properties and corrosion resistance. Although, in commercial alloys, tensile strengths higher than 70,000 lbs./in.^{2} are readily obtained, other factors may control alloy choice; in wrought alloys corrosion resistance, ease of fabrication, and formability may be more important than strength, and for castings ease of fabrication or castability may dominate.

A rationalization of the precipitation theory with respect to Al-Cu alloys is presented by W. L. FINK, D. W. SMITH & L. A. WILLEY ("Precipitation-hardening of High Purity Binary and Ternary Aluminum-copper Alloys", Preprint 36, 23 pp.). Their work during the last 5 years has shown that there is no justification for modification or complication of the simple theory of precipitation-hardening originally advanced by Merica, Waltenberg and Scott. The authors believe that age-hardening in Al-Cu-Mg alloys is accomplished by precipitation of an Al-Mg constituent and of an Al-Cu constituent; attempts are now being made to identify these precipitating phases. Also, work is underway to determine why 1% Mn has no greater effect than 0.5% Mn in decreasing precipitation hardening of Al-Cu alloys. The principal effect of Fe added to Al-Cu alloys is to remove Cu from solid solution to form the insoluble Al-Cu-Fe constituent, with consequent suppression of age-hardening. This same explanation of the mechanism by which Fe suppresses age-hardening of Al-Cu alloys was also advanced by H. Y. HUNSICKER ("Precipitation-hardening Characteristics of High Purity Aluminum-copper and Aluminum-copper-iron Alloys", Preprint 12, 23 pp.) after determining lattice parameters of suitable Fe-bearing Al-Cu alloys and observing an almost linear decrease in Cu concentration of the Al-Cu solid solution, with increasing Fe concentration.

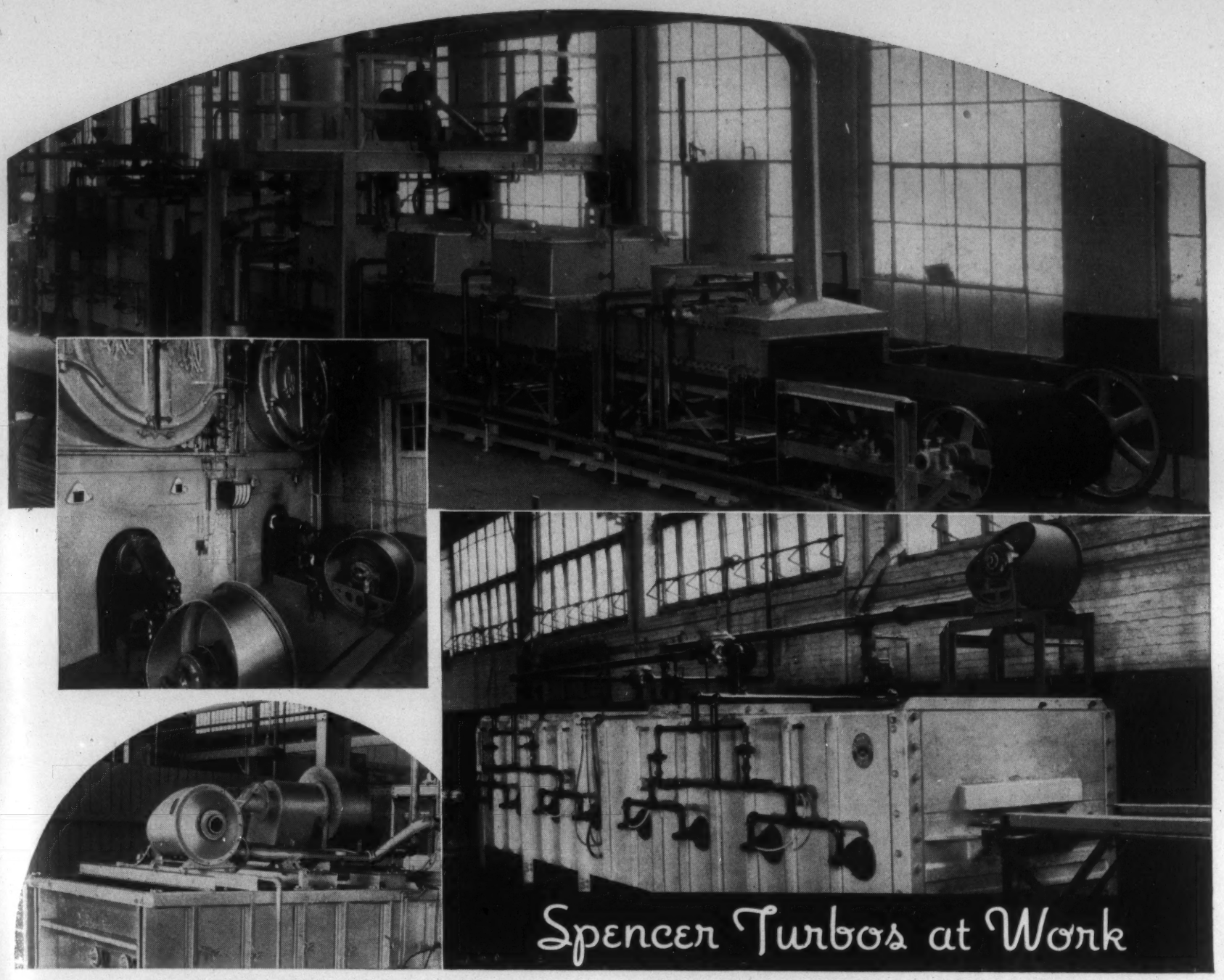
Among the heavy alloys to which knowledge and utilization of precipitation-hardening has been extended are the Fe-W and Fe-Mo series. W. P. SYKES ("Precipitation-hardening in the Heavy Alloys", Preprint 37, 35 pp.) reports a mass of data on the effects of various controllable factors (identities of solvent and solute, atomic concentration of solute, precipitation temperature, degree of solid solution supersaturation at precipitation temperature, presence of non-metallics, and existence of a second metallic phase) on the age-hardening performance of several alloys of the Fe-W and Fe-Mo series. There seems to be no effect of solute concentration on diffusion rate, at least for intermediate aging temperatures; the diffusion rate of Mo in α-iron is evidently higher than that of W. Hardness data indicate that hardness measurement as a method is not well adapted to the quantitative study of changes within an alloy during the earliest stage of the hardening cycle. Such changes in hardness that do occur here are more pronounced in the less concentrated alloys and are most easily detected at the lowest temperatures of aging. Hot-hardness tests showed that the difference in hardness between 2 different Fe-W alloys at 800° C. is of the same relative magnitude as shown by room temperature tests on the alloys in their hardest state.

An unusually comprehensive review of age-hardening Cu alloys, supplemented with a 164-reference bibliography, is given by D. K. CRAMPTON ("Age-hardening Copper Alloys", Preprint 38, 40 pp.). Unlike the general systems previously considered, the factor of electrical conductivity is frequently of controlling importance in the suitability of age-hardening alloys of the Cu system. Although it is impossible to achieve simultaneously the maximum of both mechanical and conductivity properties, excellent compromises are obtainable. Some 19 elements form with Cu binary alloys having the constitutional properties essential to age-hardening. A much wider use of Cu-base age-hardenable alloys is in prospect, but such materials are not likely ever to supplant the work hardening alloys in commercial importance within the industry.

Binary alloys of Cu with 3.2% Co or 2.4% Fe were studied by R. B. GORDON & M. COHEN ("Age-hardening of a Copper-cobalt and a Copper-iron Alloy", Preprint 39, 24 pp.). Both alloys undergo a 2-stage precipitation process, first at the grain boundaries and then within the grains. In the Cu-Co alloy, both types of precipitate are ferromagnetic. In the Cu-Fe alloy, the grain boundary precipitate is ferromagnetic but the general precipitate is initially not, although it later transforms into a ferromagnetic phase.

A critical review, with 382 references, of published work on the aging of iron and steel is given by R. L. KENYON & R. S. BURNS ("Aging in Iron and Steel", Preprint 40, 51 pp.). The three types of phenomena considered are (1) brittleness caused by deformation in the blue-heat range, (2) strain-aging as shown by the change in physical properties resulting from the storage of over-strained steel at room temperature or from heating over-strained steel to moderate temperatures (100°-400° F.), and (3) quench-aging, or changes accompanying storage at room temperature after quenching drastically from elevated temperatures. The first two can be classified together as strain-aging. Because steels have been freed from the tendency to quench-age by removal of the carbon before quenching, it is logical to conclude that carbon is the "cause" of quench-aging; similarly, because steels stable against strain-aging have been produced by sufficient deoxidation, it may be said that oxygen is one "cause" of strain-aging. Evidence to date shows beyond any doubt that quench-aging is a precipitation phenomenon. The evidence for this deduction is not so conclusive, however, in the case of strain-aging.

Another aspect of the subject of "strain" is discussed by R. H. HARRINGTON ("The Role of Strain in Precipitation Reactions in Alloys", Preprint 41, 27 pp.), "strain" being considered separately as thermally or mechanically caused. Particular attention is paid to "double-aging"—the use of 2 precipitation reheats, with or without previous solution treatment, and with an intermediate straining treatment. Controlled use of strain in age-hardening may effect "super-normal" as well as "preferred" precipitation



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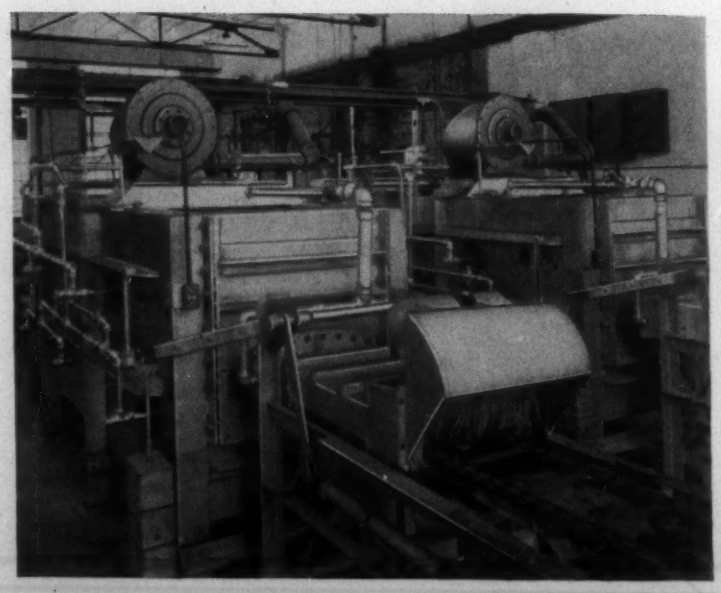

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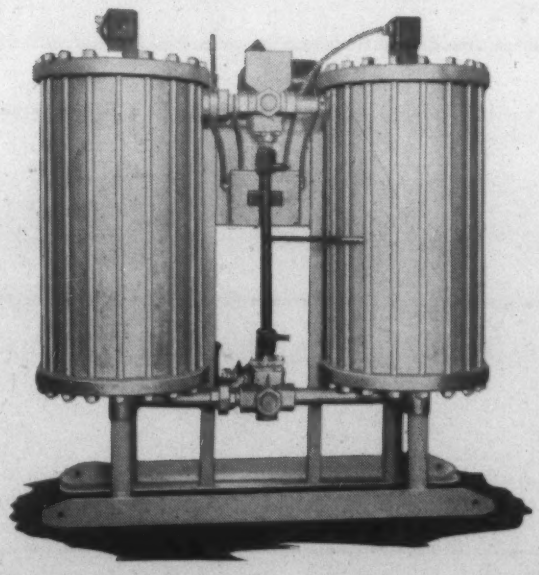

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in certain alloys. Recrystallization-hardness curves for all cold-worked solid-solution alloys may be affected by the tendency for "super-normal" precipitation to occur under the conditions of heating the plastically-strained solid solution at temperatures below those of recrystallization. This effect may stabilize the strain condition and not only produce useful combinations of properties not otherwise obtainable, but also effectively elevate the recrystallization temperature.

A masterful analysis of our present knowledge of age-hardening in binary alloys comprises the concluding paper, by R. F. MEHL & L. K. JETTER ("The Mechanism of Precipitation from Solid Solution. The Theory of Age-hardening," Preprint 30, 76 pp.). The paper, which contains 185 references, shows (among many other things) that changes in mechanical properties are of little use in deciding among contending explanations of age-hardening. The phenomena accompanying age-hardening are indeed complicated, but from available evidence it appears that the changes in properties observed may be explained on the basis of precipitation alone without recourse to theories concerning a homogeneous pre-precipitation reaction. [It will be recalled that this is exactly the same conclusion reached by Fink, Smith and Willey in their paper (Preprint 36) on Al-Cu alloys.] (5)

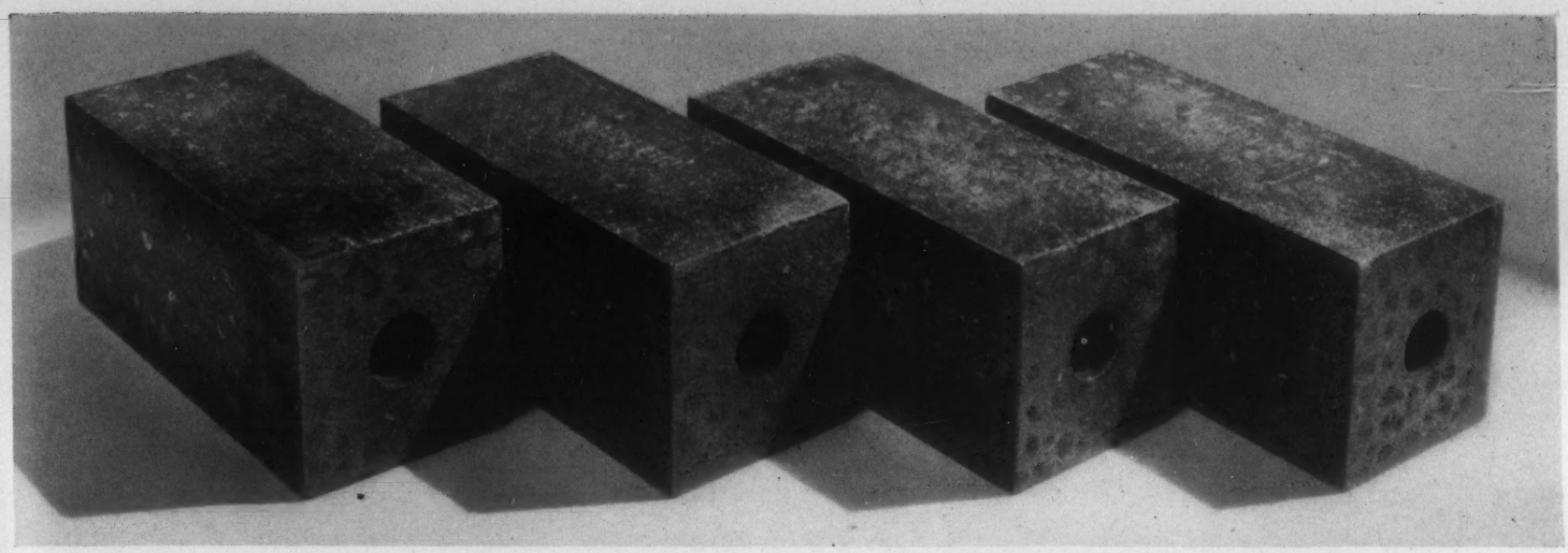
5a. Ferrous

The Influence of the Quenching Agent on the Hardening of Steel (Zur Frage der Stahlhärtung insbesondere über den Einfluss des Abschreckmittels auf den Härtungsvorgang) A. ROSE. *Mitt. Kaiser-Wilhelm-Inst. Eisenforsch. Düsseldorf,* Vol. 21, No. 11, 1939, pp. 181-196. Original research. The uniform hardening of a steel is determined not only by composition and hardening temperature, but also by the nature of the quenching agent. The characteristic properties, especially the cooling capacity, of various quenching agents were sought. The cooling capacity of a liquid is determined by formation of a vapor film, by boiling and by convection; curves are established that show the temperature ranges of these three phenomena and their quantitative effects on cooling velocity. Water as a quenching agent is characterized by high cooling velocities, especially at low temperatures, and by the instability of the vapor film. Mineral oils and fatty oils have quite different characteristics; the latter have higher cooling velocities and tend to boil uniformly over a large temperature range. Differences in the mineral oils are due to their physical properties, not to their chemical structure.

The gap in quenching capacity between water and oils can be bridged by means of emulsions, pectin or sodium silicate solutions. All quenching agents of a water base have the disadvantage of comparatively high cooling velocities at low temperatures. Numerical values for cooling velocities at 500° C. were derived from the experiments and literature for all the investigated cooling agents. These show that for any heat abstracting value from 0 to 15,000 kg. cal./m.^{2}hr.°C. a suitable cooling agent can be selected; a table gives numerical values for water, oils and air, stationary and circulating, and the heat transmission coefficients as calculated from the experiments. 31 references. Ha (5a)

Attainable Tensile Properties with Chromium-Molybdenum Structural Steels after Quenching and Quenching and Tempering (Erreichbare festigkeitseigenschaften bei Chrom-Molybdän-Baustählen noch Härtung oder Vergütung) H. VOSS & F. KRÄMER. *Stahl u. Eisen,* Vol. 59, Aug. 10, 1939, pp. 913-920. Research and data compilation. Series of Cr-Mo structural steels representing experimental melts and commercial steels were made of varying analyses in sections up to 80 mm. in diam. and were given various hardening and tempering heat treatments. The tensile properties at the surface and interior were then determined, micrographs of the corresponding structures also being shown. The results of the large number of tests are shown in graphs and tables. SE (5a)

Flame Hardening Rollers and Roller Paths. ROY L. SPAULDING (Am. Hoist & Derrick Co.) *Welding J., N. Y.,* Vol. 18, Sept. 1939, pp. 513-515. Practical. Higher hardnesses are stated to be obtainable by flame hardening than by quenching in brine, owing to the simultaneous abstraction of heat from the surface by the quenching water and the underlying mass of steel. The roller paths withstand greatly increased loads and give longer service. The process is ideally suited to large sections which could not conveniently be heat treated by furnace methods. The success enjoyed in all applications results because the method is based on the principle of heating a hardenable steel (0.35 to 0.55% C or alloy steel with similar hardenability) with such rapidity that the desired depth is brought above the critical temperature range while the main portion of the body remains essentially unheated, and immediately following the heating cycle by a suitable quench to develop the desired hardness. The hardening operation may be performed after machining since it does not damage the surface or cause excessive distortion. It therefore



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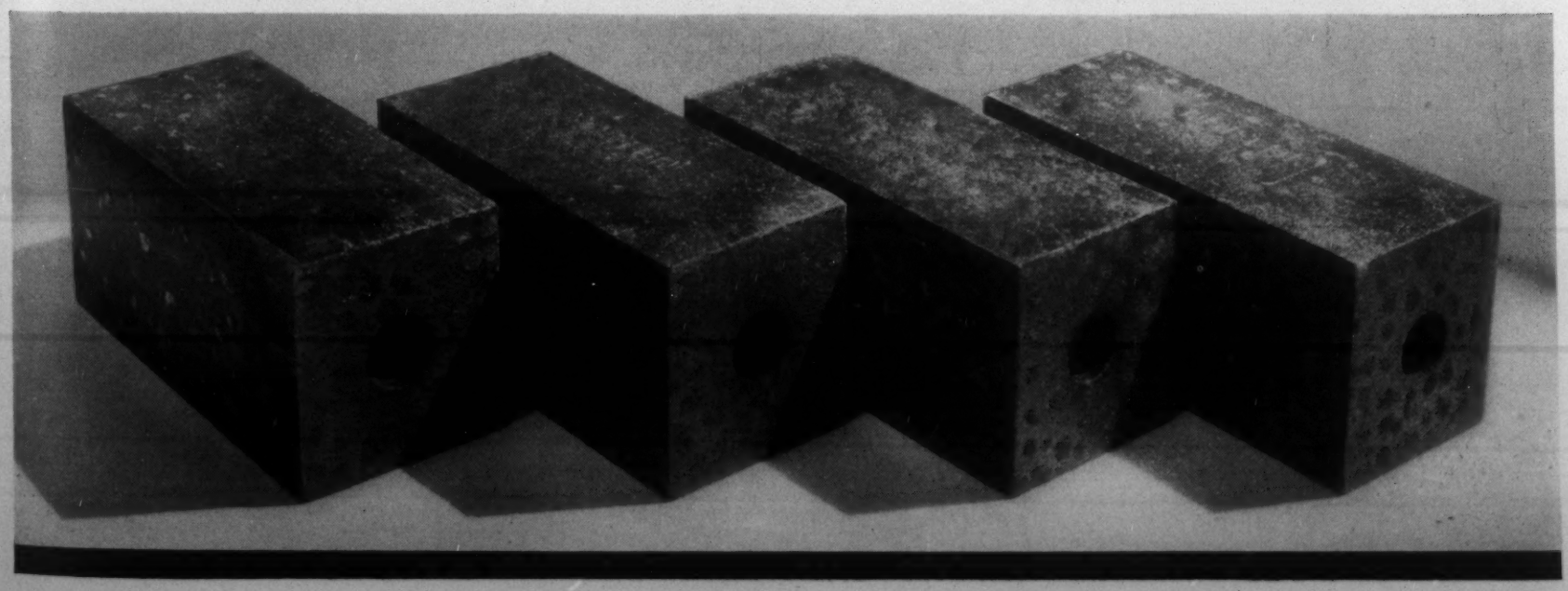

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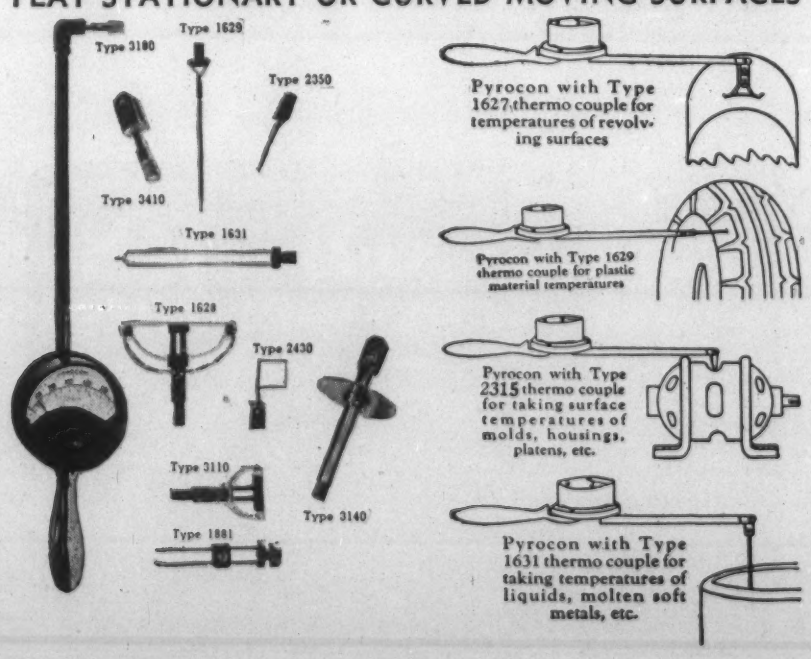

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eliminates the expense of machining hard material. The author found that the angle at which the torch strikes the surface is not critical and may be varied 30° from the vertical but the tip should be sloped about 3° ahead of vertical to obtain best flame and quench stability and gas economy. Methods of restricting the softening of previously hardened areas during torch hardening in circular path are considered. This area may be decreased to about 1/16 in. by the use of a copper shield flooded with water, which is placed over the previously hardened section, thus increasing the temperature gradient. WB (5a)

Annealing of Low Carbon Rimmed, Aluminum-killed and Silicon-killed Steels. W. P. WALLACE & R. L. RICKETT (U. S. Steel Corp.) *Preprint, Am. Soc. Metals*, Oct. 1939, 18 pp. Research. The effect of time and temperature of annealing and amount of prior cold reduction on the structure and hardness of 3 commercial low-C steels when annealed under carefully controlled conditions was investigated. A rimmed, a Si-killed and an Al-killed steel, all containing 0.15% C or less, and all cold reduced various amounts ranging up to 81% reduction in area were employed. The temperature range covered was 900° to 1350° F. and periods of 15 min., 2 hrs. and 16 hrs. at each annealing temperature were used. Results of the investigation are expressed in the form of numerous curves relating the annealing variables, amount of prior cold reduction, and type of steel, severally or individually, to hardness and in some instances degree of recrystallization and grain size. Photomicrographs of a few representative structures are included.

The lowest amount of cold reduction that produced definite deformation of the grains observable under the microscope was 30%. After cold reductions of less than 18% no distortion of ferrite grains was evident, nor were small, new, equiaxed grains ever observed after annealing at 1000° F. Relatively coarse grains were found after annealing at higher temperatures, particularly for long times. When annealed at 1350° F. some austenite formed in the Al- and Si-killed steels; consequently, pearlite was present in the annealed product. In the very low-C rimmed steel practically no austenite formed at 1350° F. or below. The material is pearlite-free after annealing, but contains carbide as discrete particles. A gradual drop in hardness (recovery) results from annealing at the lower temperatures, without visible microstructural change. A pronounced drop in hardness, due to recrystallization and grain growth, occurs on annealing at high temperatures; the minimum annealing temperature that results in such a sharp drop in hardness is lower the greater the amount of prior cold reduction, the longer the annealing period, and varies with the steel being treated.

Complete recrystallization or marked grain coarsening occurs more readily in the rim portions of the rimmed steel and less readily in the core portion of the rimmed steel than in the other two steels investigated. Another difference between rim and core of the rimmed steel is the very coarse grain size in the rim as compared to the core when annealed at 1100° F. or higher for 16 hrs. after relatively small amounts of cold reduction. The rim and core of the rimmed steel softened more on annealing at 900° F. ("recovered" more) than did the killed steels; this may be because 900° F. is nearer the temperature of beginning of recrystallization for the rimmed steel than for the other two. The Al-killed and Si-killed steels investigated behave very much the same; both are less readily recrystallized than the rim portion of the rimmed steel and more readily than the core. The only consistent difference in behavior between the Al- and Si-killed steels is observed when annealed at 1100° F. at which temperature the Al-killed steel recrystallizes and softens after smaller amounts of cold reduction than does the Si-killed steel annealed for the same length of time. Although slightly harder, the killed steels tend to be slightly coarser grained than the rimmed steel core treated similarly; of the two killed steels, the Si-killed grade tends to be the coarser grained, although the difference is very slight. (5a)

Transformation of Austenite on Cooling; Morphology and Genesis of the Aggregates Formed. H. JOLIVET. *J. Iron Steel Inst.*, Advance Copy No. 5, Sept. 1939, 20 pp. Original research and review. An attempt is made to classify the structures formed in low-alloy steels during isothermal decomposition of the austenite in the upper ranges (Ar′) and the intermediate (Ar″). In addition to pearlite and troostite there are granular structures formed in the lower portion of the upper range that have no special designation. The structures observed were typical of their temperatures of formation. They are governed by the relative extent of the growth of the elements formed and the formation of new centers of formation. Nuclei formed may be either ferrite or cementite, depending on the temperature of formation, the original nuclei being cementite for Ar′ and supersaturated ferrite for Ar″. Some good micrographs of the structures under discussion are shown. JLG (5a)

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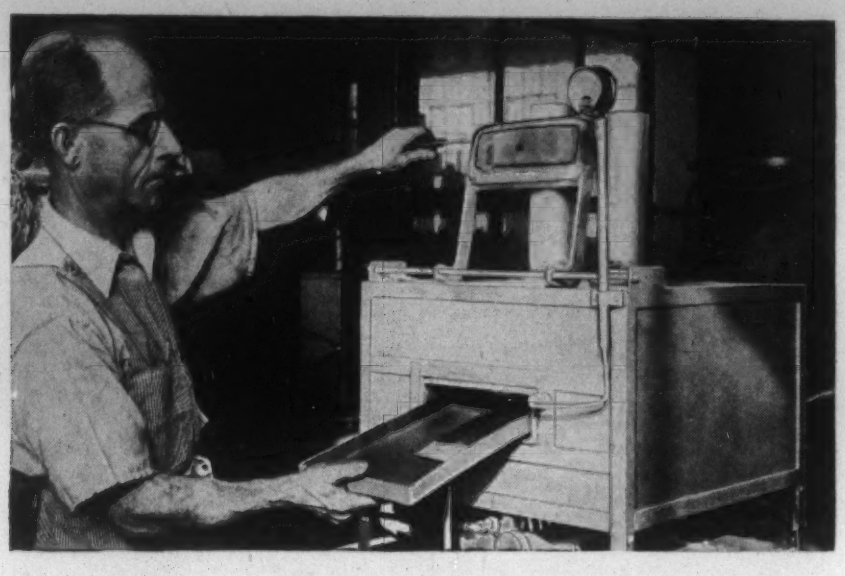

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Modern Trends in Nickel Steel and Nickel Cast Iron Gear Materials. C. M. SCHWITTER (Int'l Nickel Co.) *Paper, Am. Gear Mfrs. Assoc.*, Oct. 1939, 23 pp. Comprehensive review and data compilation. The choice of alloy steel for a specific gear application is governed by the mechanical properties, which must be such that the gear will satisfactorily meet its service requirements, and by the fabricating qualities, which must insure (1) economical machinability with adequate accuracy, and (2) response to simple heat treatment with a minimum of distortion and freedom from cracking. Two types of alloy steels, carburizing and direct hardening, are generally used for gears. The Ni carburizing steels are employed where exceptional toughness in the core combined with an extremely wear-resistant surface is required. Current design is often more concerned with compressive stresses developed on the engaging tooth surfaces than in the actual strength of the teeth, particularly with high speed gears. Experience has established that when compressive stresses do not exceed a permissible compressive strength of the steel used, the gear teeth are not likely to fail by pitting in service.

Heavy duty applications are served best by the more highly alloyed types, such as "Krupp," S.A.E. 4815, 2515 and 4320 steels. For intermediate service, S.A.E. 2315, 3115 and 4615 are widely used. When high core strength is desired, it is customary to use these steels with a raised carbon content (0.20%)—a practice which results, in many cases, in better machinability in the annealed condition. Although recognized in the past as producing optimum properties in both case and core, double quenching treatments are seldom practiced commercially today. Steels (such as S.A.E. 4615) that respond suitably to a single quench are currently preferred. The surface hardness of the direct-hardening Ni steels is generally improved by the use of a cyanide bath as the heating medium for hardening, resulting in the formation of a superficial hard skin up to 0.005 in. in depth. The most useful property of the more highly alloyed steels is their ability to harden more completely when quenched in heavy sections. S.A.E. 4640 and S.A.E. 3150 are generally used for automotive, bus and tractor transmission gears. S.A.E. 2350 is employed for high quality gears of small or medium sections. S.A.E. 3250, 3450 and 4340 are used for moderate and heavy duty gears in which extreme depth hardening is required. The direct hardening steels may be heat treated as bar stock and machined without further treatment, or they may be treated essentially as the carburizing steels, *i.e.* rough machined, heat treated and finished.

Any alloy steels that respond satisfactorily to direct hardening treatments should be capable of flame hardening. Hardenability, core properties and freedom from distortion and risk of cracking should be considered when flame hardening. As in the carburizing steels, the core properties largely determine the strength and toughness of the teeth, while the hardened surface determines its resistance to wear and compression. Many gear and tool manufacturers have standardized on S.A.E. 4640 Ni-Mo steel for flame hardened parts, although the S.A.E. 3200, 3400 and 4300 steels have also enjoyed some popularity and the process has even been applied to carburized S.A.E. 2300 and 3100 steels.

A valuable quality of the nickel nitriding steels, in addition to the exceptionally hard surface produced, is the relatively low temperature (900°-1000° F.) at which nitriding can be performed and its attendant elimination of the risk of distortion. Nickel Nitralloy, which is essentially a regular nitriding steel containing 3.5% Ni, has also the advantage of being a precipitation hardening steel which develops in the core, as a result of exposure to the nitriding temperature, a strength and hardness considerably in excess of its original properties. This steel can be machined to finished dimensions in a relatively soft state after suitable preliminary treatment consisting usually of normalizing, quenching and tempering at 1200°-1300° F. The nitriding treatment will then provide a suitable wear resistant case of 950 to 1100 Vickers and automatically strengthen the core to values exceeding 175,000 lbs./in.^{2} tensile strength. Recent experiments with S.A.E. 4340 indicate that this composition also responds satisfactorily to nitriding treatments. Standard practice is reported to produce a case hardness of 600 to 700 Vickers.

In the case of cast iron, the choice must include consideration of the casting qualities of the composition specified, along with service properties and ease of machinability. An important characteristic is the possession of uniform, dense grain structure which has no tendency to be open or porous in the heavy sections nor to form localized clusters of carbides in the light sections or at the edges. The chief detriment to machinability is the formation of chill or localized hard spots in chilled areas. Nickel additions obviate these chilled areas, promote structural uniformity, and permit machining at high hardness levels at equal speeds or at higher speeds for equal hardness than in the case of plain iron.

In many gear applications the principal requirement is resistance to wear. Wear resistance can then be achieved without sacrifice in machinability by refinement and hardening of the pearlitic matrix. Where exceptionally high strength is required, ladle

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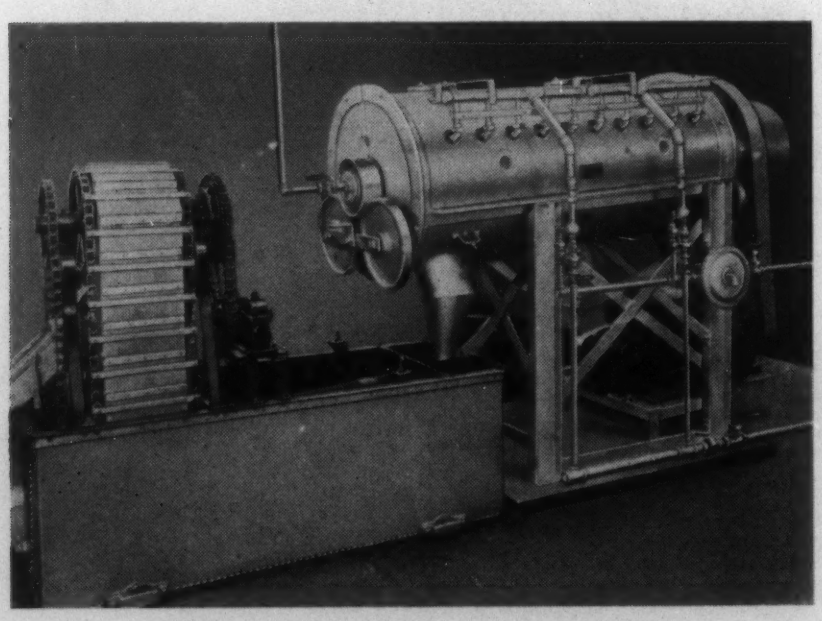

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inoculation by means of Si additions and other deoxidizers is invariably employed; total carbon content rarely exceeds 3% and often is as low as 2.40%. Nickel-, Ni-Mo-, and Ni-Cr-Mo-irons are generally used. Heat treatment, while entirely feasible, is not as yet widely used. Flame hardening may be applied successfully if suitable alloy compositions are employed, but as yet no practical applications to cast iron gears have been reported. (5a)

New Method of Selective Hardening. R. S. MINARIK (Armour Inst. Tech.) *Heat Treating Forging,* Vol. 25, Aug. 1939, pp. 377-378. Describes a method for producing the desired, but hitherto commercially unattainable, hard spot on the striking faces of hammers and drifting tools. The ideal longitudinal section of a hammer barrel should consist of a relatively soft matrix supporting a very hard face having a shape somewhat like an oval (part of curve above horizontal axis is considerably flatter than that below). Differential quenching failed to produce the desired results, so it was decided to induce a differential temperature field in steel and quench by total submergence. A preliminary trial was made by focusing an acetylene welding-torch flame at the center of the hammer face, and, after this area reached the desired temperature, dropping the hammer into water. This gave a section in which the entire surface of "button" read approximately 85 scleroscope and the matrix, 40. The line of demarcation between these hardness areas was very sharp. One electrode of a resistance type rivet heater was clamped about the circumference of a cylinder (0.55-0.60% C basic open-hearth steel). The other electrode was made to contact a specific central area of the face. The form and location of electrodes control the pattern of current field and therefore the induced temperature field. Section of field was designed to give temperature values which decreased as one moved farther from central electrode. The device was completely successful in achieving the desired result. MS (5a)

Heat Treatment of "Substitute" High Speed Steels Low in Tungsten (Beitrag zur Wärmebehandlung wolframarmer Austauschschnellarbeitsstähle) W. HAUFE & E. BÜRKLIN. *Tech. Zentralbl. prakt. Metallbearb.,* Vol. 49, July 1939, pp. 519-524; Aug. 1939, pp. 593-594. Review plus original research. Scaling of low-W high speed steels is no greater than that of steels high in W. The Mo cutting steels are more resistant to oxidation than those of the W type. The depth of decarburization during heat treatment increases with the Mo content, and with this is associated a greater tendency toward surface cracking in hardening. The difficulties encountered in hot working the Mo-type high speed steels during the World War have since been overcome. The starting temperature of heat treatment should not exceed 1100° C. and the finishing about 900° C. The Mo steels are soft-annealed at a lower temperature than the W steels, namely 800°-820° C. On annealing 30-50 hrs. the W steels lose about 30-40% of their efficiency, the Mo-steels 10-15%. The microscopic changes during 6 different hardening treatments are shown. The most suitable hardening temperature, varying between 1180° C. and 1230° C., depends on the exact composition of the Mo steel. Diagrams are presented giving the hardening times in relation to the dimension of the tool. The authors favor the use of lower hardening temperatures and extended hardening times. Welding Mo high peed steels to open hearth steel does not offer difficulties. The low-W cutting steels, however, are more susceptible to over-heating than are those low in W. Greater precautions are thus required for the hardening treatment. It is concluded that the new "substitute" (*Austauschstähle*) tool steels are absolutely equivalent—sometimes superior—to the former high-speed steels high in W, if their working and hardening specifications are observed. The new steels are cheaper because of the low W content and the lower specific weight. The widely encountered prejudice that the performance of a high-speed steel depends on the total amount of alloy addition is still obstructing wider adoption of the new tool steels. EF (5a)

5b. Non-Ferrous

Trends in Annealing Practice for Copper and Its Alloys. Modernized processing practice, new furnace designs and the fast-growing use of controlled atmospheres are outstanding among recent general trends in the heat treatment of copper, brass, bronze and nickel-silver. Specific developments are reviewed in 3 recent interesting articles in American publications.

A useful resumé of modern annealing practice is given by R. D. HAWKINS of Bridgeport Gas Light Co. ("Present Practice in the Heat Treatment of Non-ferrous Metals and Alloys," *Wire & Wire Products,* Vol. 14, Sept. 1939, pp. 464-469). Methods used in sheet mills, tube mills, wire mills, rod mills and fabricating plants with their particular requirements and equipment are discussed at length. Copper and, in general, Cu-Si, low Cu-Sn

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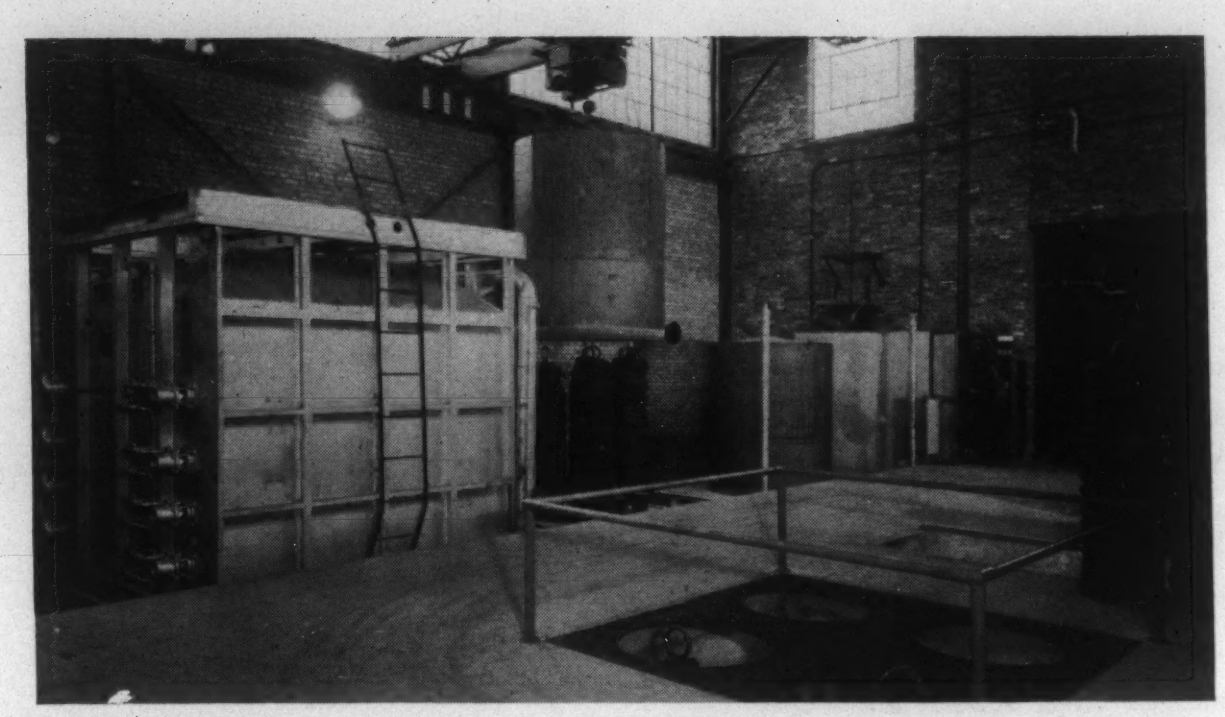

Gas-fired radiant tube annealing furnace in plant of Wilson Steel and Wire Co., Chicago, makers of tinned, galvanized, annealed and bright wire, all sizes of nails, tacks and rivets, as well as bale ties and straight and cut wire. Photograph courtesy Surface Combustion Corporation.

In the plant of the Wilson Steel & Wire Co., Chicago, a new Gas-fired radiant tube annealing furnace turns out 14,000 pounds of wire per heat and averages 40,000 pounds per day. This output is 2½ times that of the two previously used furnaces fired with another fuel and is typical of the increased speed of production with modern Gas equipment.

Only one operator is required to handle the new furnace, compared with a fireman and two material handling men for the older furnaces. The tare heating weight of the new unit is 4,300 pounds, compared with 24,000 pounds of the old units.

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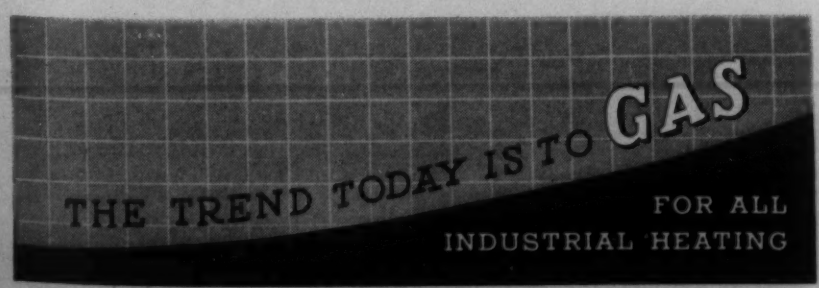

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INDUSTRIAL GAS SECTION

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(less than 5% Sn), Cu-Ni-Zn alloys, high brass and Muntz metal are rolled at about 1250°-1950° F. in the breakdown mill. All alloys of copper, nickel and brass, whether containing Sn, Si, Pb or small amounts of other elements, are cold rolled to finishing sizes. Alloys with high Sn and Pb are hot-short and cannot be hot rolled, and are therefore processed from the cake cold. Heating and annealing furnace types are briefly described. In general, they consume about 0.5-0.65 ft.^{3} of 530 B.t.u. gas per lb. of copper or brass treated, depending on type of furnace; hairpin or double-deck furnaces have somewhat lower fuel consumption —about 0.4-0.45 ft.^{3} of gas per lb. of metal. Piercing mills and extrusion processes are used for tube production, the former being able to handle a wider range of sizes. In fabricating plants, working temperatures run from 1200° to 1800° F., depending on the alloy.

Recent important changes in practice for forming and processing copper and brass have impelled improvement in furnace design, particularly with respect to mechanization, according to H. M. HEYN of Surface Combustion Co. ("New Design in Copper and Brass Furnaces", *Ind. Gas*, Vol. 18, Oct. 1939, pp. 12-15). As in the case of furnaces for treating ferrous metals, there is a decided trend to controlled atmospheres, especially for the finishing operations. Several new slab heating furnaces have been designed on the principle that close operating control during breakdown operations avoids subsequent processing difficulties and improves the final product. Such furnaces employ a novel slab-stacking mechanism, by which the slabs are stacked in two rows to capacity on an elevator-table, which automatically rises the height of one slab. Mechanical arms reach out from the furnace, strip one slab from each pile and pull them on the furnace conveyor. This loading cycle is repeated at the beginning of each heating cycle. Slabs pass through the furnace on a walking-beam conveyor, and at the discharge end are cooled by water-spray, guided into uniform piles, and picked up by a crane. Because the slabs travel through the furnace only one-high, heating is more rapid and uniform than in the old pan-type furnaces. The new furnace is comparatively short and is fired from the charge end by suitably-spaced long flame burners.

Radiant-tube controlled atmosphere furnaces with roller-hearth conveyors are increasingly used for annealing (particularly finish-annealing) narrow sheet in coils. The DX atmosphere leaves copper bright and clean; brass has a slight discoloration easily removed by a flash pickle. Another type of controlled atmosphere furnace consists of a heating cover, which is transferred successively to each of 3 bottom-water-sealed inner covers placed on 3 bases, each containing a center spindle loaded with coils. Heating of this type avoids the development of large thermal heads and of temperature non-uniformity, often the cause of coarse or irregular grain size.

Growing in popularity are batch-type furnaces heated by recirculated gases; heat is supplied by an external heater mounted atop the furnace. Rapid and uniform heating result from the intimate contact of hot gases with the work and the transfer of heat by convection rather than radiation. Direct-fired continuous furnaces—capable, by modifying gas-air ratio at the burners, of producing either bright or oxidized sheet—are frequently employed for flat sheets. For round billets in tube mills, the walking-beam conveyor type of furnace is popular. For break-down and finish annealing, the direct-fired controlled atmosphere furnace is being installed more extensively, as contrasted with a few years ago when muffle and radiant type controlled atmosphere furnaces predominated. A novel feature in one such furnace, to prevent air filtration at low production, is provision for maintaining furnace pressure above the danger point by burning more than the normal amount of gas and cooling the hot combustion-products in a water tower to prevent overshooting the desired temperature; an ordinary recirculating fan serves to move the combustion-products from the furnace to the cooling-tower.

In another report, HAWKINS ("Trends in Application of Atmospheres to Heat Treatment of Copper and Copper Alloys", *Report of Non-ferrous Metals Comm., Ind. Gas Section, Am. Gas Assoc.*, Oct. 1939, 4 pp.) emphasizes that the trend in controlled atmosphere equipment is toward simplification of furnaces and elimination of as much auxiliary equipment as possible. There is a growing use of convection heating for work of poor heat-absorbing capacity. Direct-fired convected-gas furnaces in which the products of combustion developed in heating the furnace are employed as protective atmosphere are coming into prominence. This method eliminates the multiplicity of burners generally common to direct-fired furnaces, with consequent simplification of maintenance and control. Atmosphere troubles in bright annealing copper have largely been eliminated. Difficulties arising from the presence of sulphur compounds in the gas can be avoided by holding the CO content of the atmosphere below 1½ or 2%, and by keeping the temperature of the atmosphere generator above 2,000° F. At this time, however, no commercially successful process is available that can produce bright-annealed brass; the best that is regularly attained is "clean" annealing with a slight discoloration. X (5b)

6 Welding and Cutting

Including Brazing, Hardfacing, Riveting and Soldering. For Flame-Hardening, see Section 5.

E. V. DAVID, SECTION EDITOR

The Use and Application of Portable Spot Welding. C. E. HEITMAN (Edward G. Budd Mfg. Co.) *Paper, Am. Welding Soc.*, Oct. 1939. Describes recent trends in the application of portable spot welding, as brought about by developments in spot welding equipment. Portable spotwelders have many disadvantages as compared to stationary welding machines. The former are usually heavy and cumbersome, and on high speed operations cable failures occur all too frequently, in spite of water cooling. The process, however, fills a need in industry, and although many of its applications are destined to be replaced by automatic multi-spotwelding machines, it will continue to serve economically for many purposes.

A portable spot welder consists of a portable welding gun, by means of which pressure is applied to the parts being welded, a welding transformer which may be stationary or movable, and which is electrically connected to the welding gun by means of flexible welding cables, and means for applying and timing the electric current to the transformer. Such welders can be subdivided into 2 classes: (1) Those applied to production line fabrication where the unit is semi-portable, in that it forms a permanent part of that particular production line and is portable only in the sense that it is movable through a relatively short distance; (2) those applied to job-shop fabrication wherein the quantity production of any one part does not justify a production line, and where one piece of equipment may see duty on many jobs in different parts of the shop in any one working day. It is in the job shop that portable spot welding has its greatest future. The very name "job shop" implies comparatively low production for any one design, where the cost of automatic machines can usually not be justified. This method finds wide-spread application in the fabrication of railway cars and equipment as well as in the construction of numerous products of stainless and of mild steel for many other industries.

The gages of metal commonly welded vary from a minimum of 2 thicknesses of 0.004 in. to 2 thicknesses of 3/16 in. It is obviously impractical to cover this entire range of welding with one size of welding equipment, because of the wide range of welding currents necessary. Experience has shown that 5 different sizes of equipment, namely: 10, 25, 50, 100 and 200 Kva, give the best economic balance. The welding tools in common use vary from a small tool weighing 15 lbs. and developing 200 lbs. electrode pressure, to a tool weighing 300 lbs. and developing 8,000 lbs. electrode pressure, with many other intermediate sizes and designs. All are considered portable in that they are carried to the job, although of course it is necessary to support the larger ones by means of some balancing arrangement. (6)

How to Select the Correct Alloy for Hard-surfacing Applications. CHARLES E. MACQUIGG (Ohio State University) *Welding Engr.*, Vol. 24, July 1939, pp. 15-18. Practical. Hard-surfacing means adding suitable metallic layers to the original surface. In general, the best resistance to wear is associated with the greatest surface hardness. To meet adequately the various requirements of hardness, toughness, shock resistance and other qualities, various hard-facing alloys of widely different compositions have been developed. These may be divided into four groups: (1) low-alloy steels—Mn, Cr, Mo, V, and W are the most commonly

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used alloying elements, generally with C about 0.3 to 0.6%. Alloying constituents are less than approximately 5%. (2) High-alloy steels—Mn, Co, W, and Ni may be used as alloying ingredients, invariably with high Cr. Alloying constituents are present in excess of 10%. Because of the long life of these alloys, they are frequently more economical in the long run than the less expensive metals. (3) Non-ferrous alloys of Co, Cr and W, which have the unique property of red hardness. (4) Tungsten carbides and borides are the hardest and most wear resisting of all hard-facing materials. These diamond substitutes are furnished in the form of small castings known as inserts, and in the form of welding rods in which the hard particles are packed in tubes of steel.

In order to select intelligently the correct hard-facing material for any particular application, it is necessary to determine those factors that cause deterioration of the wearing part. In the table the 4 groups are arranged for each characteristic in decreasing order of merit (best group at the left of each line):

Characteristic of Deposit	Order of merit of foregoing groups			
Cold Hardness	4	2	3	1
Red Hardness	4	3	2	1
Resistance of Impact	1	2	3	4
Corrosion Resistance	3	2	1	4
Smoothness of Deposit	3	1	2	4
Ability to Scour	4	2	3	1
Thinness of Welding	3	2	1	4

All plain C and low-alloy steels may be hard-faced, provided the C content is not substantially in excess of 0.5%. Higher C and alloy contents require, under some circumstances, special heat-treatments subsequent to the surfacing operation, and pre-heating of the part to be surfaced may be required. Gray cast iron and alloy cast irons are readily hard-surfaced. On the other hand, brass, copper or bronzes cannot be hard-surfaced because of their relatively low melting points. CEJ (6)

Welding (Gas) Techniques and Methods. F. CLARK. *Welding Ind., London*, Vol. 7, July 1939, pp. 201-205; Aug. 1939, pp. 248-253. Practical. A brief survey is presented of the gas welding methods available today, with an indication of their various advantages and efficiency. The production of a good weld is not a simple matter, and usually depends upon 4 principal items: (a) the welding technique or method employed, (b) the preparation of the welding edges, (c) the flame adjustment, the welding rod and, if necessary, the flux, and (d) the control of distortion by clamping, weld sequence and direction. Three distinct types of flame adjustment are in daily use—the neutral flame, the oxidizing flame and the carburizing flame. The haphazard method of flame adjustment usually produces a flame that is definitely oxidizing. The ideal neutral condition is that in which the luminous cone has a small "dart" or "haze" immediately on its extremity. The tiny flickering so produced facilitates inspection and is the best tell-tale a welder can have. Care should be taken to avoid the tendency to use an unnecessarily large nozzle and then to hold the flame a long way from the surface of the metal, in order to compensate for the intensity of the heat produced by the large nozzle. The flame temperature, some 3100° C. at a point just beyond the end of the luminous cone, remains the same whatever the nozzle size, variation of nozzle size providing only a greater or less quantity of volume of heat.

It is important to select a welding wire that will reproduce the service requirements of the job. The diameter of welding wires for ferrous welding by the downhand techniques is generally about the thickness of sheet up to 1/8 in.; for plate welding above this thickness it is about half the thickness of the plate. For vertical welding of ferrous plate exceeding 1/8 in. thickness the diameter should not exceed 1/3 the metal thickness, while for non-ferrous plate, it would be about half the plate thickness. The oldest known system of welding is what is known as "forward" welding, and this is what has become generally known as leftward technique, because when applied by a right-handed welder holding the blowpipe in the right hand, the direction of welding is usually carried from the right to the left. This technique is efficient for most sheets of metal, almost any thickness of non-ferrous alloys and cast iron. On steel, however, its economical upper limit is between 3/16 in. and 1/4 in. thickness; above that thickness the rate of welding decreases rapidly, gas consumption increases, and the cost becomes uneconomical and out of proportion to the cost on thicknesses for which the technique is economically suited. However, fortunately there is a newer technique known as backhand welding, which, still with the blow pipe held in the right hand, is used for welding in the opposite direction to forward welding, i.e. from left to right. The economical lower limit of this technique is between 3/16 in. and 1/4 in. so that it is able to carry on where forward welding ceases.

When the thickness of metal exceeds about 5/16 in. the size of the single welding flame becomes so large that there is likely to be too much heat concentration at one point on the weld. Multi-jet torches are then usually used. The principal multi-tip welding torches employ 2 nozzles only, the main jet for welding and a preheating jet for preheating the edges ahead of the weld point. The Lindewelding technique employs either single or multi-jet blowpipes, and features the use of a carburizing flame, that is, a flame having an excess of acetylene. The technique can be applied only to mild steel; the excess acetylene flame contains free C, and, when the flame is applied to the surface to be welded, that surface, at a certain temperature, absorbs this C. This high-C low-melting-point layer is of infinitesimal thickness, but it is sufficient to reduce the temperature at which efficient fusion can be ensured between the deposited weld metal and the base metal. The advantage for the method is that weld metal can be deposited more rapidly.

For vertical welding a modification of the leftward or forward technique is used. For rightward welding, edges of steel plate up to 5/16 in. thick need not be beveled. Above that thickness, rightward-welded steel plates need to be bevelled to 30°, providing an angle of 60°. Leftward welding necessitates bevelling to 40°-45° to provide an included angle of 80°-90°. Lindewelding necessitates a slightly larger vee than is normal for rightward welding, and one of 70° is usually recommended. CEJ (6)

Automatic Electric Arc Welding Without Auxiliary Machinery (Selbstätige Lichtbogenschweissunge ohne maschinelle Hilfseinrichtungen) G. HAFERGUT. *Z. Ver. deut. Ing.*, Vol. 83, Aug. 19, 1939, pp. 951-952. Descriptive. Hitherto, long seams have been welded automatically with special welding machines. A new process is described in which the electrode is placed directly in the correspondingly prepared seam, in which it is held close to the surface by a simple device, and connected to one pole of the welding generator. The seam becomes absolutely uniform, and as the joint is shielded during the melting process the slag covers it uniformly, and the electrode melts uniformly under it without contamination from atmospheric oxygen. An ordinary piece of paper is placed between the holding device and the electrode to absorb in its combustion already-present O near the joint. Mechanical tests are said to have shown that the seam is as good as the parent material. Electrodes up to 1.5 m. long (5 ft.) have been used with good results. The procedure is described in detail; the process is more economical, as no over head because of costly auxiliary machinery has to be charged. Ha (6)

6a. Ferrous

Experiments with Single Sided Welding of a Vessel's Hull Plating. V. K. POLESHIUK. *Soudostroienie*, No. 2, 1939, pp. 94-98. In Russian. (Abstracted in *Welding Lit. Review* Vol. 1, Aug. 1939, p. 112.) Up to the end of 1935 the Soviet shipyards engaged in building small river craft with all-welded steel hulls invariably welded the seams of the hull plating on both sides. As the thickness of the plates used in the construction of such craft was extremely light (2, 2.5 and 3 mm.) this frequently caused serious deformation of the hull and extensive buckling of the outer plating. In 1937 it was accordingly decided to attempt the construction of a sea-going motorboat by welding the plating on one side only. The dimensions of the boat were 68 ft. 4 in. x 11 ft. x 6 ft. 10 in., the maximum draught being 3 ft. 3 in. The hull plating had a thickness of 3 mm. while the bottom was of 4 mm. plate. A number of modifications were made in the disposition of the framing to facilitate single-sided welding of the plating and much of the hull was pre-fabricated prior to assembly on the slip.

The effect of this method of construction as regards hull deformation and plate buckling was carefully observed at all stages of the work, elaborate measurements being taken. It was found that the maximum resultant deformation and buckling was considerably less than with double-sided welding and that an appreciable saving in labor and material (electrode) was also effected. The article is illustrated by a number of drawings and diagrams showing the arrangement of the hull framing and plating and the method of welding the various seams and angles under both the double-sided and single-sided systems of welding. A table showing the extent of the maximum buckling, the current used for welding, and the time taken is also appended. (6a)

Welding of Steam Electric Locomotive. W. H. COCHRAN (Gen. Elect. Co.) *Welding J., N. Y.*, Vol. 18, July 1939, pp. 405-409. Descriptive. Low alloy, high tensile steel with 0.12 C, 1.50 Cu, 1.00 Mn, 1.00 Ni, 0.20 Mo was found to be suitably welded with C-Mo heavily-coated electrode to give 66,300 lbs./in.^{2} yield strength, 80,000 lbs./in.^{2} tensile strength with 37% free bend for a 1-in. plate in the unannealed condition. After annealing at 725° C., these values became 59,700, 68,750 and 55%, respectively, for the 1-in. plate. Some of the members of the frame section had to be fabricated from plate stock into box section and Tee section structural shapes. Loading tests to

destruction were made for important members. For the high-pressure steam line operating at 1500 lbs./in.^{2} and 900° F., welded C-Mo piping was used. All pipes above 1-in. diam. were arc welded and those below 1-in. were welded with oxyacetylene torch because of less likelihood of burning through the pipe with the latter method. On 2-in. and larger pipe, a chill ring was used with a butt weld, but for pipe between 1 and 2 in. in diam. a fillet welded sleeve type joint was made. All joints on C-Mo pipe were preheated to 200° F. before welding, held at this temperature during welding and given a local stress relief anneal after welding. WB (6a)

Recommended Technique for Manual Welding of Vee Butt-Joints in Steel Plate. C. T. GAYLEY. *Welding Engr.*, Vol. 24, July 1939, pp. 31-32, 40. Practical. The average welder seems to have most of his trouble in welding the root of the joint in the vertical position. The root of the overhead weld is second in this respect. While the multiple-bead method of filling in a vee butt joint has been succeeded by the woven layer technique in nearly all shops, still the reason for a great deal of failure in properly welding the root in the vertical position seems to be in the persistence of the string bead technique for the root of the joint. A technique in which the first and second passes are deposited in thin, flat, or even concave layers is the most desirable.

The author suggests the following technique: The root layer is put down with a short and rapid transverse weave coupled with a short "whip" up the backing strip after each four rapid and short traverses in the horizontal direction. In other words the path of the arc described is an inverted "T." The whipping should not be carried more than ½ in. above the crater—or as short as possible and still keep the weld metal in place. The transverse movement may be no more than 3/16 in. The path of the inverted "T" should be traversed about 60 times a min. The second layer is put in with a fast transverse weave and no whipping. At the end of each transverse a brief pause is made to penetrate the edge of the plate. During the pause, the electrode is not advanced to maintain the normal arc length, but is allowed to melt away for an instant, thereby lengthening the arc and eroding the side of the bevel a little distance upward, so that no undercut shoulder will be left. The remainder of the groove should be filled up with other relatively thin layers, using the transverse weave technique similar to that used in the second layer. A very slight pull-up on the sides may sometimes be desirable. In making overhead vee-joint butt welds, the same technique should be used as that described for vertical welds. CEJ (6a)

Flame-cutting Steel for Welding. E. DACRE LACY. *Metal Treatment*, Vol. 5, Summer 1939, pp. 67-71. Descriptive. Flame-cutting can be used to shape parts that are later to be welded, and if the technique is correct only the merest trace of oxide will be left on the cut surfaces. With mild and medium C steels, at least, no more oxide inclusions are to be expected than with machined edges, and the welds will be as sound. Either portable or stationary machines may be used, and a uniform movement of the cutter is essential. For repetition work, the use of a machine which operates several burners simultaneously is generally preferable to stack cutting. Pure oxygen in adequate amounts is essential, and if freezing occurs through too rapid expansion of the oxygen, a warming device should be fitted to the regulator and several oxygen cylinders connected to the manifold. Stainless and high alloy steels cannot be cut. JCC (6a)

The Thermal Distribution and Temperature Gradient in the Arc Welding of Oil Well Casing. W. A. BRUCE (Carter Oil Co.) *J. Applied Phys.*, Vol. 10, Aug. 1939, pp. 578-584. Mathematical. Applying the Kelvin method of heat sources the temperature distribution in an infinite plate due to a heat source moving with constant speed, and thus the general effect of a moving welder, was obtained. From the fact that an infinite plate with an infinite number of heat sources in a line is equivalent to an infinite cylindrical shell with "n" equally spaced sources "w" units apart on a circumference $c = nw$, it was possible to work out a very general solution. Certain simplifications and approximations of this solution are given together with a correction factor to be used when welding is done with a backing plate. An experimental test of the solutions deduced in practical casing welding is described. HFK (6a)

Important Considerations in the Use of High Tensile Steel Rivets in Shipbuilding. W. G. DUBOSE (U. S. Navy Dept.) *Society of Naval Architects & Marine Engrs.* Preprint No. 6, Nov. 1939, 32 pp. Survey. Rivets of medium Mn steel (0.20-0.30% C, 1.35-2.10% Mn) driven hot into galvanized plates are prone to crack at points that touch the Zn coating. The cracks are intergranular and show penetration of Zn. Exhaustive studies were made using statistical methods of evaluating data, together with the examination of mild steel rivets and the Mn steel rivets driven in both black and galvanized plate. A variety of alloy steel rivets tested showed behavior similar to the Mn steel rivets, nor did changes in Mn content appreciably affect results. Driving temperature is a major variable; the hotter the rivet, the worse the results. Filleted rivets and chamfered holes are advantageous to decrease stress concentration as well as to remove Zn from the immediate vicinity of the rivet. In highly-stressed joints removal of Zn from the mating surfaces of the plates is also advisable. Driving temperatures must be held below 2200° F. Medium-C steel rivets are not as sensitive as the Mn steel rivets, but all the precautions save removal of Zn from the plate mating surfaces should nevertheless be taken.

The results show that the cause of trouble is penetration of molten Zn. The remedy is to remove nearby Zn and to avoid melting the Zn that is farther away. The investigation is very complete and the account conclusive. HWG (6a)

6b. Non-Ferrous

Brazing the Aluminum Alloys. G. O. HOGLUND (Aluminum Co. of America) *Paper, Am. Welding Soc.*, Oct. 1939. Reviews the present status of the use of brazing methods for joining parts made from Al and Al alloys. Although the process is one of comparatively recent development, it has been applied successfully on several commercial applications, and has aroused considerable interest in those fields where the low cost of batch brazing can be applied to Al alloy parts on somewhat the same basis as is now done on other metals. Experience to date indicates that 3 brazing methods are practicable: Furnace brazing, dip brazing and torch brazing. In furnace brazing, the parts are assembled, fluxed and brought to a temperature above the melting point of the filler metal but below the melting point of the parent metal. Dip brazing is accomplished by assembling the parts in jigs to maintain proper mating of faying surfaces and applying brazing heat by dipping the assembly in molten flux, held at a temperature that will wet the surface of the parent parts and permit the filler material to flow into the joint. Torch brazing resembles very much the conventional gas welding process, except that a filler material of low melting point is used with a special brazing flux so that little or no melting occurs in the parent material.

Furnace equipment for brazing Al alloys is essentially the same as that used for brazing other materials, the major difference being that the brazing temperature is lower than for ferrous materials; a temperature range from 1,000° to 1,200° F. is used on all present applications that are now in production or being considered. All of the production brazing operations to date have been accomplished in an air atmosphere. Experimental work with the commonly used controlled atmosphere made by partial combustion of natural gas, coke oven gas, butane or propane, has not indicated any advantage in this type of atmospheric control. Good results, on the other hand, can be obtained with a pure hydrogen atmosphere, although it has not yet been necessary to use this gas in actual practice. The alloys for which successful brazing processes have been developed include commercially pure aluminum (2S), an Al-Mn alloy (3S), an Al-Mn-Mg alloy (4S), and an Al-Si-Mg-Cr alloy (61S). The strength of brazed joints in these alloys is about the same as the strength of torch-welded joints. Pressure tests on some applications have shown that the joints are sufficiently sound to handle at least 90 lbs./in.^{2} air pressure. This can probably be exceeded considerably. Other tests with water have been carried up to 1,700 lbs./in.^{2} hydrostatic pressure without leaking. No difficulty from the standpoint of tightness is anticipated in brazed joints, assuming the design of the parts is adequate to carry the pressure. Brazing processes should substantially reduce the cost of joining Al alloys as compared with standard gas or arc welding methods. They provide neater joints requiring less finishing, and extend the range of other than soldered joints to parts thinner than could heretofore be considered. (6b)

The Brazing of Copper. L. L. WYMAN (Gen. Elec. Co.) *Wire & Wire Prod.*, Vol. 14, Oct. 1939, pp. 565-571. Practical. Physical and electrical requirements in the equipment for continuous brazing of copper is discussed. Although initially more expensive, silver-copper brazing solders are used with advantage and economy, the eutectic alloy (72% Ag, 28% Cu) being the best as it has the highest electric conductivity. But even with less Ag the joint will be electrically and physically satisfactory if the ratio of the brazed area to the cross section is about 3:1. Lap joints are preferable to most other types of joint. While the eutectic 72/28 Ag-Cu alloy melts at 1435° F., other Ag-Cu alloys have a temperature range between liquidus and solidus which can sometimes be utilized to advantage; *e.g.* if it is necessary to braze in several steps, a 30/38/32 is used for the first step and later a 55.5/4.5/40 Ag-Cu-Cd alloy for the second step, as their melting points are 1455° and 1265° F., respectively. A table is given for brazing solders of different melting points and physical properties to be selected for given cases, from 864° to 1600° F., and brazing methods and equipment are described. Ha (6b)

7 Finishing

Pickling, Cleaning, Sandblasting and Polishing. Electroplating, Metallizing, Galvanizing and Tinning. Coloring, 'Oxidizing' and Non-Metallic Finishing.

H. S. RAWDON, SECTION EDITOR

Dropping Tests for Measuring the Thickness of Zinc and Cadmium Coatings on Steel. ABNER BRENNER. *J. Research, Natl. Bur. Standards,* Vol. 23, Sept. 1939, pp. 387-403. Research. The dropping test was reinvestigated because of reported difficulties with the end point. Improvements were made in the apparatus to permit a more constant rate of dropping of the reagent. For comparison, some thickness tests were also made by the jet, magnetic, and microscopic methods. The ammonium nitrate dropping-test reagent did not give a satisfactory end point with zinc-mercury coatings and did not dissolve different types of bright cadmium coatings at the same rate. A chromic acid reagent, containing 200 g./l. of chromic acid and 50 g./l. of sulphuric acid, overcame these difficulties and had the additional advantage that only one reagent was required for testing different types of Zn and Cd coatings. On commercial specimens, this reagent gave an average error of ±12% and maximum errors of about ±20%. The jet method and the microscopic method are not very satisfactory for measuring the thickness of Zn and Cd coatings. The magnetic method usually yields errors less than ±15%, and appears satisfactory, except for thin coatings on rough basis metals.

The following recommendations are made: (1) The chromic acid reagent is recommended in preference to the ammonium nitrate reagent for testing Zn and Cd coatings. (2) Even with the chromic acid reagent, a tolerance of —20% should be allowed on individual thickness measurements to take care of uncertainties in the end points, especially of coatings from different sources. This tolerance may be included directly in the minimum thickness specified. (3) The magnetic method is promising and certainly useful for plant control. Additional commercial experience will be required before it can be included in formal specifications. (4) The use of the microscopic method for umpire tests should be confined to laboratories having experience with these particular measurements. (5) For many purposes the stripping method with hydrochloric acid and antimony trichloride is preferable as an umpire test. A piece with a total area of 1-4 cm.^{2} is cut from that portion of the article where the thinnest coating is suspected. It is carefully weighed (to 0.1 mg.) and the portion of its surface not to be stripped is coated with an acid-resistant lacquer, which is removed after the stripping and prior to reweighing. This method is usually reliable well within ±10%. WAT (7)

Metallic Films from the Gaseous Phase (Metallschichten aus der Gasphase) R. RITSCHL. *Metallwirtschaft,* Vol. 18, June 30, 1939, pp. 563-566. Review (with bibliography) of developments in the technique of producing metallic films from the vapor state by cathodic dusting or vaporization in a vacuum, as well as their uses and properties. Of major importance in producing a satisfactory film is the treatment of the surface of the quartz, glass or mica upon which the film is to be deposited. The author has found hydrogen peroxide solutions to be satisfactory for cleaning glass and quartz. When using the cathodic dusting process cleaning is accomplished by reducing the pressure in the discharge chamber till the cathode rays strike the mirror. For the vaporization process an auxiliary electrode serves through the discharge of an induction coil to clean the mirror surface. The cathodic dusting process is briefly described. Use of argon or neon instead of hydrogen or air atmosphere has led to increased efficiency, because deposition occurs five times as fast in argon as in hydrogen. In the vacuum vaporization process the metal to be plated is heated in a vacuum (about 1/10 mm. mercury) in a tungsten wire spiral. The equipment must be vacuum-tight and provided with mercury or oil diffusion pumps of a high pumping capacity, as during the heating process much gas is given off. In the vaporization of aluminum, an oxide film is formed which hinders the evaporation. Heating the aluminum to a light yellow color will cause the skin to break and the metal will vaporize with great rapidity. A second difficulty encountered in the vaporization of aluminum is the tendency of the aluminum and tungsten to alloy, with consequent burning-through of the thin tungsten wire. Large diameter wire however will operate satisfactorily.

In some metals the vapor pressure is quite high even before the metal is molten. In this case, current can be passed through wires of the metal to be vaporized. Silver and nickel have been deposited in this manner. Numerous processes for measuring the thickness of films have been used, of which measurement of change in weight is the most common. This method, however, is subject to inaccuracies of weighing and to varying density, the density of a film not always being the same as that of massive metal. X-ray measurements have been used to determine the thickness of films about 10 A.U. thick. X-ray density measurements have shown the density of vaporized nickel films to be 10% less than that of the metal. Density measurements on silver have shown the density of the film to be the same as that of the metal. Application of the thin films is greatest in the optical field. In the infra red region silver and gold give the best results in regards to reflectivity. In the visible portion of the spectrum up to 4000 A. U. silver has the highest reflectivity. Aluminum has the most uniform reflectivity from long to short waves, and at the same time possesses excellent stability. GA (7)

7a. Electrolytic Methods

The Influence of the Basis Material on the Quality of Electrogalvanizing (Ueber den Einfluss des Grundmaterials auf die Qualität der galvanischen Verzinkung) HANS DIENBAUER. *Kalt-Walz-Welt,* Aug. 1939, pp. 57-60; Sept. 1939, pp. 65-68. Original research. The basis materials comprised Si-free, soft, hot-rolled open-hearth steel sheets (0.07% C, 0.38 Mn, 0.014 P, 0.036 S, 0.24 Cu) and electric-steel sheets (0.07% C, 0.45 Mn, 0.011 P, 0.038 S, 0.02 Si, 0.11 Cu), and the same materials in cold-rolled, bright-annealed coils. Samples were taken from different parts to study the effect of segregation zones. Corrosion resistance, porosity, hardness and adherence of deposits of 0.01 and 0.02-mm. thickness (about 70 g./m.^{2} and 140 g./m.^{2} surface respectively) were tested. Exposure tests in industrial atmospheres and alternating-immersion corrosion tests in 20% NaC[1] solution were made (The latter tests failed to give useful results since the corrosion salts coated over the Zn coating.)

With the O. H. steel sheets a somewhat higher corrosion resistance of the Zn layer was found for those samples from the bottom of the steel ingot, in comparison with the other samples, whereas with the other materials the results were, in general, opposite in character. However, definite relations between corrosion stability and zone of segregation could not be established. The Zn deposits on the O. H. sheets proved the most stable, followed by electric steel sheets and O. H. coils. The least corrosion stability was shown by the deposits on electric steel coils. With the O. H. sheets (0.01-mm. deposit) the deposits on the samples from the center and head of the ingot showed many more pores than those from the bottom of the ingot. Samples from the center of the ingot showed highest porosity. No decrease of porosity from ingot head to ingot bottom was apparent with electric-steel sheets. Both with O. H. and electric-steel sheets samples from the rim of the segregated zone and the ingot axis show smaller porosity than those from regions between. Similar porosity numbers result for coils, regardless of whether O. H. or electric steels were used. Samples rolled from the head of the ingot show small porosity, while those from center and bottom of ingot are practically pore-free. With larger deposits (0.02 mm. one-sided) porosity decreases and is practically zero with O. H. steel.

The hardness was determined with a Martens scratch-hardness tester. Variation in basis material had no effect on the hardness of the Zn deposit. Experiments to determine the adherence of the Zn deposit according to the method of Burgess failed. No differences of adhesion were revealed by double-folding tests. Open-hearth and electric-steel sheets possessed the same Erichsen cupping values, and galvanizing affected the drawability as tested

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by the Erichsen method only to a very small extent. The bending numbers of both types of sheets increased from ingot head to ingot bottom, and *vice versa* with coils. Open-hearth coils possess the highest, electric-steel coils the lowest bending values. The values for the sheets were intermediate. The Zn deposit adheres tighter on O. H. than on electric-steel and on coils better than on sheet. GN (7a)

The Structure and Properties of Bright Nickel Deposits. A. W. HOTHERSALL & G. E. GARDAM. *J. Electrodepositors Tech. Soc.* Vol. 15, 1939, pp. 127-140. Original research. Three types of bright Ni deposits were investigated: (a) Ni-Co alloy deposited from a bath containing sodium formate and formaldehyde. (b) Ni deposited from a bath containing 5 g/l. of nickel naphthalene trisulphonate. (c) Ni deposited from a bath containing 30 g/l. of sodium isopropyl and naphthalene sulphonate. Ordinary Ni deposits appear matte because the surface consists of irregular mounds which scatter reflected light. The mounds do not have plane surfaces or crystal facets. Bright Ni deposits have a very small grain size and the surfaces are very smooth. The luster of thin (0.0001 in.) deposits of bright Ni was highest on a smooth, fine grained surface. On coarse-grained surfaces the deposits had to be 0.0004 in. thick in order to appear fully lustrous. The bright deposits do not show any definite microstructure. The etched cross-section showed large numbers of lines parallel to the cathode surface. These lines are depressions caused by preferential etching, but no explanation is advanced for their production. These lines were not found on deposits of the "b" and "c" type that had been annealed *in vacuo* at 300° C. Deposit "c" began to recrystallize at 300° C. When the annealing was done at 1000° C. *in vacuo,* all three bright deposits developed a fair grain size.

The stress in the deposits was measured by the bending of a steel strip which was plated on only one side. Deposits "a" and "c" had a higher stress than ordinary dull Ni, but deposit "b" had practically no stress. By a bending test, deposit "a" was found to be almost as ductile as ordinary Ni. Deposits "b" and "c" were brittle. X-ray examination of "a" and "c" yielded a diffuse reflection, indicating a grain size smaller than matte Ni deposits. Deposit "a" showed some orientation of the crystals, but "c" did not. The carbon content of the deposits were: "a," 0.05%; "b," 0.07%; "c," 0.2%. The cathode potentials of the deposition of "a" and "c" were 0.02 v. and 0.15 v., respectively, more negative than the potentials of the deposition of matte Ni. The porosity of bright deposits was about the same as matte deposits, except when the bright deposits contained cracks. AB (7a)

A Study of Silver Plating for Industrial Applications. A. J. DORNBLATT, C. S. LOWE, & A. C. SIMON (Am. Silver Producers Res. Project, Natl. Bur. Standards) *Monthly Rev. Am. Electroplaters' Soc.,* Vol. 26, Aug. 1939, pp. 593-614. Original research. The corrosion resistance of Ag makes it useful as a container for foodstuffs. The authors studied the electrodeposition of Ag on the inside of containers. As pore-free Ag deposits were required, the porosity of Ag coatings was studied. The porosity of Ag on steel was determined by the ferroxyl test and the hot water test. Normal variations in cleaning, pickling, agitation of bath, current density, and temperature, had no significant effect on the porosity of deposits, although overpickling increased porosity. Careful filtration of the Ag plating bath was necessary. A deposit 0.0001 in. thick on polished oxygen-free Cu was practically nonporous. 0.0005 in. of Ag was required to secure pore-free deposits on steel that had a good surface. The porosity of thinner Ag coatings was affected by the quality of the steel surface. By brush-plating, nonporous deposits 0.0002 in. thick were obtained on steel. The porosity of Ag coatings on a Cu or Ni undercoat was determined. Cu plating was done in a Rochelle salt cyanide bath. Ag deposits 0.0001 in. thick plated on a pore-free Cu undercoat, 0.0005 in. thick, were pore-free with respect to the Cu as well as the steel. Ni undercoats were less effective than Cu.

The information gained in the porosity tests was applied to the Ag plating of two types of containers: (1) Non-returnable steel cans were plated with 0.001 in. of Cu and 0.0001 in. of Ag, the cost of the latter being about $0.01 on a 12 oz. can. (2) Returnable steel barrels were press-formed from plated steel sheet. The coating consisted of 0.002 in. of Cu, followed by a flash of Ni and 0.001 in. of Ag. The Ni prevents alloying of Cu and Ag, with subsequent blistering, when the two barrel halves are brazed together. Forming operations did not detach or perforate the plated coating. AB (7a)

The Electrodeposition of Lead from Solutions of Lead Sulphamate with Addition Agents. FRANK C. MATHERS & ROBERT B. FORNEY (Indiana Univ.) *Trans. Electrochem. Soc.,* Vol. 76, Preprint No. 6, 1939, 10 pp. Original research. A plating bath of lead sulphamate has some advantages over the lead fluosilicate bath, as it does not attack ceramic vessels and is somewhat cheaper. Sulphamic acid, $HSO_3.NH_2$, is now commercially available at 10-12 cents per lb. It is a fairly strong acid. The plating bath contained 5.4 g. of Pb and 5 g. of sulphamic acid per 100 cc. The current density was 0.22 amp./dm.^{2} at room temperature. The cathode current efficiency was 96% and the anodes corroded with slightly over 100% current efficiency. Deposits obtained under different conditions were compared after 20 consecutive hrs. of plating. Without addition agents, the bath gave a badly treed deposit. About 200 experiments were made with different addition agents or combinations of addition agents. The following combinations of addition agents gave smooth, finely crystalline deposits (the quantities refer to 100 cc. of bath): (1) 0.07 g. β-naphthol and 0.7 g. aloin. (2) 0.05 g. casein and 0.1 g. aloin. (3) 0.5 g. malic acid and 0.1 g. aloin. (4) 0.5 g. pyrogallol and 0.7 g. aloin. (5) 0.3 g. resorcinol and 0.1 g. aloin. (6) 0.7 g. glue and 0.07 g. β-naphthol. (7) 10 drops cresylic acid. (8) 0.1 g. resorcinol and 0.5 g. goulac. (9) 7 drops furfural and 0.5 g. aloin. AB (7a)

7b. Non-Electrolytic Methods

Rust-Inhibiting Pigments; Aluminum-Silicon Alloys in Germany. F. KIPPING. *Chem. Trade J.,* Vol. 105, Sept. 1, 1939, pp. 180-181; also in *Metallgesellschaft Periodic Rev.* No. 14, Aug. 1939, pp. 27-31. Descriptive. Deals with properties and uses of "Sigal," a metal pigment consisting essentially of the eutectic alloy of 87% Al and 13% Si, with addition of elemental Si. It is produced in electric furnaces. Pieces, of a coarse crystalline structure, are broken down in the hot state and, after sieving, are further reduced to particles 3 mm. in diam. in edge-runners. These are finally ground to a very fine powder in a ball-mill with air separation. Sigal paint film has outstanding covering power, great tenacity, good elasticity, and high tensile strength. Elasticity and breaking strength are superior to those of paints containing red or white Pb. Elasticity increases with increasing substitution of resinous materials for linseed oil. Sigal priming coats contain no oil, while finishing coats may contain up to 5.8% linseed oil only. Pigment has sp. gr. of 2.3, which results in more covering power per lb. The paints are non-poisonous. Because of these features and the outstanding rust-inhibiting properties, Sigal paints are being increasingly used for the protection of valuable iron and steel structures. Special grades have been developed to withstand chemical attack and moisture. A special heat-resisting grade, known as "HI," is capable of withstanding temperatures up to 550° C. under certain conditions. An important advantage from the German point of view is that this pigment is produced almost exclusively from domestic raw materials. MS + Ha (7b)

The Uneven Zinc Distribution on Sheets During Galvanizing (Das "Abrinnen" feuerverzinkter Bleche beim Trockenverzinken) HEINZ BABLIK, FRANZ GÖTZL & RUDOLF KUKACZKA. *Z. Metallkunde*, Vol. 31, Aug. 1939, pp. 287-290. Original research. An extensive micro- and macroscopic investigation on the uneven thickness of Zn coatings in galvanizing disclosed 2 causes for this feature: (a) The occurrence of cementite crystals at the surface directly under the rolling scale, and (b) an insufficiently high Al addition to the Zn bath. An extended pickling operation removed the surface layer enriched in Fe_3C crystals and resulted in better coatings. However, this method is not feasible commercially because of the great losses in Fe, time, and pickling solution it entails, and also because of excessive hydrogen absorption during pickling. Experiments on a 1.3%-C steel dipped for time periods up to 60 min. in a bath of (a) electrolytic Zn and (b) an alloy of electrolytic Zn and 0.2% Al, at 450° C. showed that the Fe losses are very drastically reduced by the Al addition. In coatings produced in the Al-treated Zn bath, the uneven distribution of the Zn coating was practically eliminated. EF (7b)

Submerged Heat by Submerged Combustion. W. G. SEE. *Wire & Wire Prod.*, Vol. 14, Oct. 1939, pp. 553-555, 615. Descriptive. Submerged combustion consists in submerging a flame into a liquid to be heated instead of heating it, for example, by steam. The application of the method to the pickling of wire is described. In addition to providing efficient heating, the method also furnishes effective stirring, so that the rate of scale removal from the steel is increased; this agitation effect permits operation at lower temperature (160 instead of 190° F.) and the temperature is more uniform and constant. The production in lbs./man-hr. is also increased. Such direct firing in the pickling solution evaporates water, increases the acid concentration and lowers the level of the liquid, so that in practice only water need be added to maintain the correct working level. Acid is lost only in the chemical reaction and by drag-out. It is said from 25-50% acid and 50% of operating cost is saved, as compared with ordinary methods of heating. In one case this saving amounted to 97c per ton of steel pickled. Ha (7b)

8 Testing and Control

Methods and Equipment. Physical and Mechanical Property Testing. X-Ray and Magnetic Inspection. Spectrographic Analysis.

W. A. TUCKER, L. S. REID AND G. R. HARRISON, SECTION EDITORS

Thermoflux Measures Plate Thickness. ALFRED V. DEFOREST (Mass. Inst. Tech.) *Iron Age*, Vol. 144, July 13, 1939, pp. 82-85. Practical description of a convenient thermal method of field inspection for wall thickness measurements when only one side of metal is available for test. Measurement is made by applying controlled rate of heat for limited time, and measuring resulting rise in temperature. For steel boiler plate, heat is most conveniently generated by a.c. magnetic yoke held in contact with surface. Between legs of yoke thermocouple is applied, and rise in temperature after a definite length of time is used as thickness indication. Temperature reached will be function of magnetic properties of steel and its heat conductivity. Gives precautions to be observed and gives data on tests conducted. VSP (T-8)

Tensile Elastic Properties of 18:8 Chromium-nickel Steel as Affected by Plastic Deformation. D. J. MCADAM, JR. & R. W. MEBS (Natl. Bur. Standards) *Natl. Advisory Comm. Aeronautics*, Report No. 670, Sept. 1939, 42 pp. Review plus research. The relationship between stress and strain, and between stress and permanent set, for 18:8 alloy as affected by prior plastic deformation is investigated. Hysteresis and creep and their effects on the stress-strain and stress-set curves are also considered, as well as the influence of duration of the rest interval after cold work and the influence of plastic deformation on proof stresses, on the modulus of elasticity at zero stress (E_o), and on the curvature of the stress-strain line. A constant (C_1) is suggested to represent the variation of the modulus of elasticity with stress.

An incomplete view of the tensile elastic properties of 18:8 alloy is obtained by considering either the stress-strain or the stress-set relationship alone. Consideration should be given to both relationships. Curves of variation of proof stresses with prior plastic extension often have many wide, abrupt oscillations superposed on a gradual wavelike mean curve. The wide oscillations generally are associated with varying duration of the rest interval and with variation in the extension spacing of the experimental points. The complexity of form of the proof-stress deformation curve possibly may be attributed in part to variation of internal stress with plastic extension. With prior plastic extension, the proof stresses corresponding to small percentages of permanent set (0.001 to 0.003%) generally increase considerably to a maximum, reached at a small percentage of prior plastic extension, and then decrease to a minimum. Further extension causes irregular oscillations in the proof stresses.

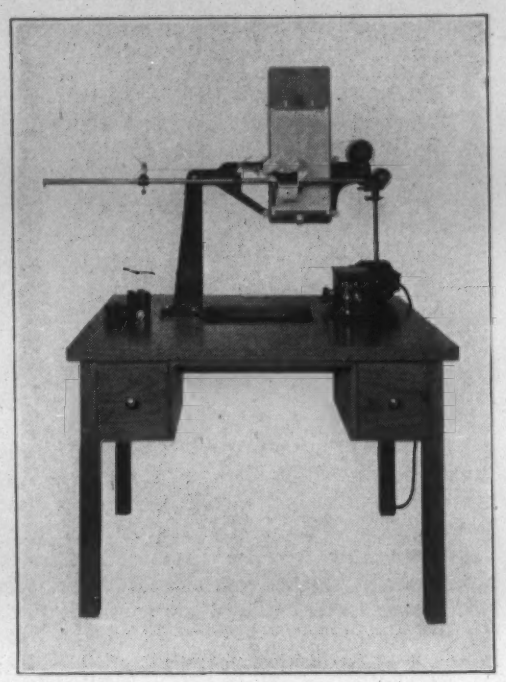
From corresponding stress-strain and stress-set curves, corrected stress-strain curves may be derived to represent approximately the variation of elastic strain with stress. From the corrected stress-strain curves there may be derived curves of variation of the secant modulus (for these curves) with stress. The stress-modulus line for annealed material that has received no prior plastic extension is strongly curved. With prior plastic extension, the curvature decreases, and generally is negligible for extensions of more than about 10%. For half-hard and hard materials, the stress-modulus lines generally are straight. Straightness of the stress-modulus line indicates that the corresponding stress-strain lines are uniformly curved. The cotangent k_1 of the angle of slope of the stress-modulus line is a dimensionless index of the degree of curvature of the stress-strain line. As an index of the fractional change of the secant modulus with stress, a suitable constant is C_1, which is equal to k_1/E_o. The modulus at zero stress E_o is obtained by extrapolating the stress-modulus line to zero stress.

In a practical estimation of the elastic strength of 18:8 alloy, the best procedure now available consists in determining the corrected stress-set and stress-deviation curves. From these may be estimated proof stresses and values of E_o and C_1. Much further information, however, may be obtained by determining (with the same specimen) a second stress-set curve and the corresponding stress-deviation curve and by deriving from these a second set of indices. In specifications for elastic strength, possible use could be made of a specified lower limit for E_o and a specified upper limit for C_1 to apply throughout a specified range of stress. In addition, specifications should include a proof-stress requirement for limitation of permanent set. (T-8)

An Apparatus for Magnetic Testing at Magnetizing Forces up to 5,000 Oersteds. RAYMOND L. SANFORD & EVERT G. BENNETT. *J. Research, Natl. Bur. Standards*, Vol. 23, Sept. 1939, pp. 415-425. Descriptive. In order to meet the demand occasioned by the recent development of permanent-magnet alloys requiring the application of very high magnetizing forces for magnetizing and testing, a new permeameter has been constructed, called the NBS High-H permeameter. In its design the aim has been to provide an instrument whose accuracy is sufficient to meet the requirements of present-day magnetic testing and which is simple and convenient to operate.

The fundamental principle is that of the well-known isthmus method, in which the magnetizing force is taken as the value of magnetic field at the surface of the specimen. By including only a relatively short length of specimen in the test, it is possible to apply the necessary high magnetizing forces without appreciable heating. Also, a symmetrical magnetic circuit promotes a uniform distribution of flux across the section of the specimen and a symmetrical distribution of field within the gap. The requisite degree of accuracy is obtained by the use of test coils whose dimensions were chosen with reference to the observed distribution of flux and field in the magnetic circuit. Furthermore, by the use of a double H-coil it is possible to determine the value of the field at the surface of the specimen more accurately than can be done with a single coil. By using a rotating H-coil, it is possible in determining points on a hysteresis loop to avoid the errors that may arise from calculating the magnetizing force as the difference of two relatively large quantities. It is estimated that for magnetizing forces from 100 to 5,000 oersteds it is possible under favorable conditions to obtain values of either induction or magnetizing force which will be accurate within 0.5%.

"IT GIVES A PICTURE OF THE WIRE"



The Scott Incline Plane Serigraph tests tensile and elongation, hysteresis or fatigue at any loading for any number of cycles. It produces a permanent chart-record of elongation, recovery, permanent loss, yield strength, ultimate strength. Many manufacturers now use this low-cost Scott Tester to get a complete "picture" of wire for fabrics, screens, filter cloth, brake bands, radio tubes, heating elements, etc. For further details, write for reprint of article recently published in M. & A.

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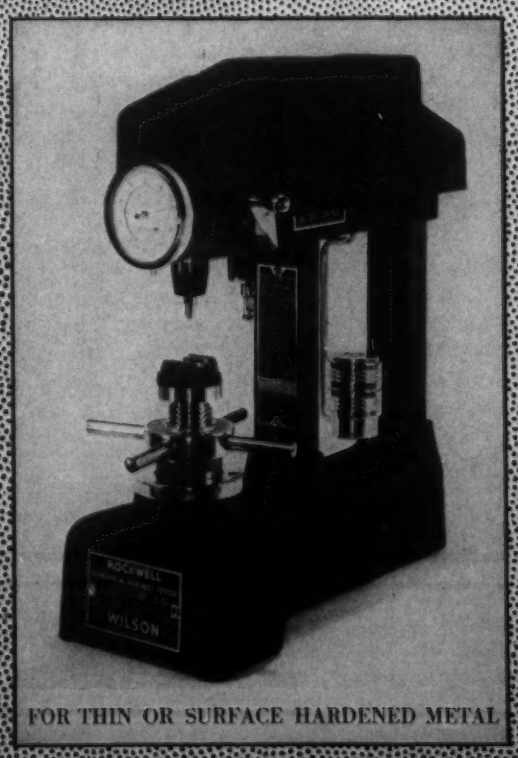

FOR THIN OR SURFACE HARDENED METAL

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Under ordinary conditions of routine testing the errors probably do not exceed 1%. Specimens of rectangular cross section up to 3.8 cm. (1.5 in.) wide and 1.9 cm. (¾ in.) thick can be tested. The apparatus is convenient and simple to operate and does not heat the specimen. WAT (R-8)

Hardness Conversion Relations for Hardened Steels. HOWARD SCOTT & T. H. GRAY (Westinghouse Elec. & Mfg. Co.) *Preprint, Am. Soc. Metals,* Oct. 1939, 18 pp. Data compilation. Reliable conversion relations between Rockwell and diamond pyramid hardness test values can be obtained on heat treated steels independent of composition. Hardness conversion tables for the major hardness tests were therefore prepared from the best available data and some new data presented here. A simple empirical equation expresses accurately the relation between Rockwell "C" and diamond pyramid test values on steels. With change of a single constant the same equation gives equally well the same relation for sintered carbides. By adding a term to this equation for elastic modulus, the new constants were evaluated from the observations on steel and sintered carbides. Values then calculated for metals of low elastic modulus, copper and aluminum alloys, agreed very well with a few experimental observations. The information presented here fully justified the use of a single reference scale of hardness for reporting all penetration hardness test values no matter which testing instrument of the kinds considered (Vickers, Rockwell, Scleroscope, Monotron, Brinell) is used.

The following highly skeletonized table is taken from the complete table in the original paper:

Diamond Pyramid Hardness	Rockwell Hardness C	Rockwell Hardness A	Rockwell Hardness Sup. 30-N	Scleroscope	Monotron	Brinell
1000	69.9	86.5	85.9	101	113	....
900	67.4	85.2	83.9	94.5	102	....
800	64.1	83.5	81.0	87.5	92	....
700	59.6	81.0	77.2	80.5	81	612
600	54.5	78.3	72.6	73.0	71	553
500	48.5	75.0	67.1	65.5	60.5	473
400	40.5	70.9	59.9	56	50	386
300	29.5	65.2	50.0	45	38.5	294

(T-8)

The Spectrographic Analysis of Tin. J. WARREN STEWART (Carnegie Inst. Tech.) *Am. Soc. Testing Materials, Preprint,* June 1939, 6 pp. Previous work on the quantitative spectrographic analysis of tin is discussed and its shortcomings indicated. After an examination of both the arc and spark methods, it was found that the spark method holds advantages over the arc method for quantitative analysis of tin, ease of use, rapidity, uniformity of results, and, in the case of determination of bismuth, sensitivity. Working curves are set up for the quantitative determination of Cu in Sn covering a range from 0.001% to 0.05%, Bi in Sn from 0.003% to 0.10%, Fe in Sn from 0.002% to 0.10%, Pb in Sn from 0.01% to 0.50%, and Sb in Sn from 0.01% to 0.50%. The method used in measuring spectrum lines is described, and the accuracy of which the method is capable is considered. VVK (H-8)

8a. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Deformation and Fracture of Mild Steel under Cyclic Stresses in Relation to Crystalline Structure. H. J. GOUGH & W. A. WOOD. *Proc. Inst. Mech. Engrs., London,* Vol. 141, Apr. 1939, pp. 175-185. Research. Attempts were made to determine by X-ray diffraction the character of the deformation and fracture of metals under static and fatigue stressing. The stress cycles were made in the immediate neighborhood of the ultimate tensile strength and of the static yield point of the material. In corroboration of previous work on this subject, it was found that under a safe range of stress, the damage to the structure is equivalent to that caused by a single sustained application of a static stress equal in amount to that of the maximum stress of the cycle. Further, the additional and progressive damage caused by cycles of an unsafe range of stress leads to a complete fragmentation of the whole or part of the specimen. A comparison of the results as regards alternating and pulsating stresses in relation to the deformation in the specimen indicates that the amount of the average stress seems to have only a small effect on the determined endurance limit of the material. Ha (8a)

different mechanical properties, particularly notch impact values. The structure found by X-rays did not agree with that found by micro-examination. Further, it was found that the notch impact values were not related to the grain structure as microscopically determined but to the structure found by the X-ray method. The notch impact values decreased with increasing grain size.

The possibility of application of the Bragg method in an asymmetric arrangement according to Backovsky (*Nature,* Vol. 141, 1938, p. 872) to the study of grain structures is pointed out. In comparison with the conventional reflection method, the Bragg-Backovsky method uses the reflection of crystallographic surfaces with lowest indices and, therefore, is very luminous. Preliminary tests with the asymmetric method prove the latter to be a useful supplement to the "reflection" methods. GN (9)

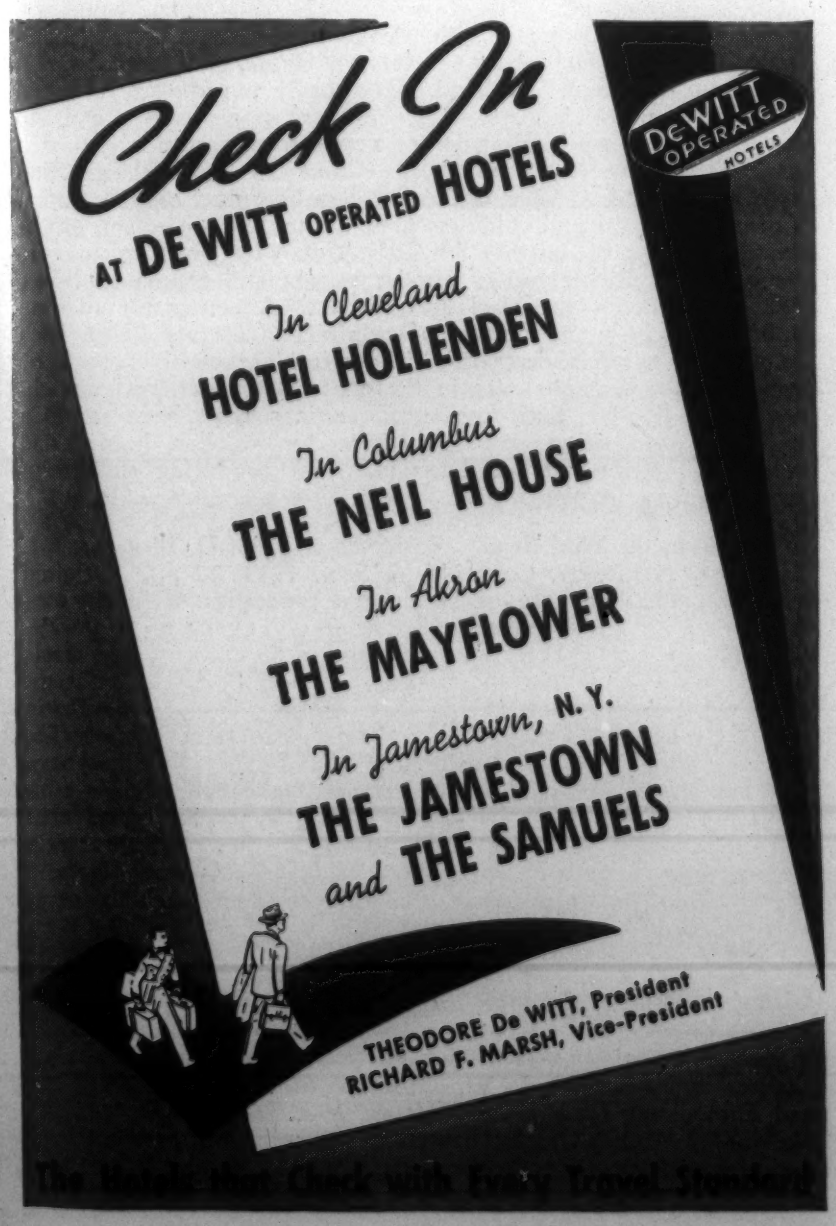
9a. Ferrous

An X-ray Examination of the Iron-rich Nickel-iron Alloys. A. J. BRADLEY & H. J. GOLDSCHMIDT. *J. Iron Steel Inst.,* Adv. Copy No. 1, Sept. 1939, 17 pp. Original research. X-ray photograms of Fe-Ni alloys were taken after long times at heat-treating temperatures. In spite of the fact that there are only 2 types of structure (body-centered and face-centered cubic), the system is quite complicated. Reactions take place at 2 definite temperatures, 580° and 350° C. Below 580° C. there is a sudden broadening of the 2-phase gap, which is quite narrow at higher temperatures. From 580° down to 350° C. $\alpha + \gamma$ 2-phase structures are found at all compositions between 6-8% Ni and 23-26% Ni. At about 350° C. the α and γ phases react to form α, with the approximate composition Fe_3Ni, which is a low-temperature body-centered phase. It was impossible to get direct evidence of the 2-phase region $\alpha + \alpha_1$, because the lattice spacings are almost identical. The $\alpha_1 + \gamma$ region stretches from about 25 to 40% Ni at 325° C. Invar, which falls in this region, may under certain conditions of heat treatment precipitate Fe_3Ni. JLG (9a)

9b. Non-Ferrous

The Nickel-tungsten System. F. H. ELLINGER & W. P. SYKES. *Am. Soc. Metals,* Preprint 31, Oct. 1939, 24 pp. Research. The diagram, constructed from microstructural, X-ray diffraction, resistivity and hardness data, shows a maximum of 1505° C. in the solidus and liquidus at 35% W. The solubility of W in the Ni-rich solid solution decreases from 40% at 1495° C., the eutectic temperature, to 38% at 970° C. Between 970° and 800° C. the solubility of W drops to 32%. At 970° C. a peritectoid reaction occurs by which is formed the intermediate phase with a W concentration of approximately 43%. This reaction involves the Ni-rich solid solution and the W-rich solid solution, the second of which dissolves about 0.3% Ni at the eutectic temperature. The eutectic occurs at a W concentration of about 45%.

Precipitation-hardening was observed in the composition range 32-45% W. Hardening takes place very slowly at 600° C. and with increasing rapidity as the aging temperature is raised to 900° C. The tendency to over-age even at 900° C. is very slight, as the maximum hardness of 490 Brinell developed in the 45% W alloy after 100 hrs. at 900° C. is reduced only some 20 points during a second 100-hr. period at this aging temperature. (9b)



Including Relation of Properties to Engineering or Product Design. See also Section 8a and 11.

M. GENSAMER, A. J. PHILLIPS and H. C. CROSS, SECTION EDITORS

Railway Passenger Cars for High-speed Service. PETER PARKE. (Pullman Co.) *Railway Age,* Vol. 107, Nov. 4, 1939, pp. 693-695, 699. Review of development and present status of light-weight high-speed railroad cars and trains. The forerunner of our modern stream-lined cars was the German State Railway's "Flying Hamburger"—a 2-car articulated, fully streamlined double-ended train introduced into service between Berlin and Hamburg in March 1933. American railroads were simultaneously developing light-weight high-speed stream-lined equipment. Today our luxuriously equipped light-weight cars are wider and longer than the older conventional-steel cars and yet the weight is 30% less. Power and power equipment savings have been great and passenger-acceptance considerable.

Originally, light-weight car construction was based on either Al alloy (pioneered by Pullman) or stainless steel (pioneered by Budd Mfg. Co.). The development of the much cheaper low-alloy high-strength rust-resisting steels provided a new and eagerly welcomed medium. At present, 4 general types of light-weight car structures are being built: (1) All-aluminum alloy (17ST) car of riveted girder-type side construction, lighter by several thousand lbs. than any other, but more costly; (2) stainless steel car of truss-frame construction with "shot-welded" connections, with the outside sheets functioning as covers rather than strength members; (3) low-alloy, high-strength, rust-resisting steel truss-frame cars of all-welded construction, with sides covered with light-gage corrugated stainless steel—these cars weigh about the same as all-stainless cars of equivalent strength; and (4) welded-girder car constructed throughout of low-alloy, high-strength steel—weighing only a trifle more than the truss-type car, but less expensive. The present trend is back to non-articulated cars, for maximum flexibility in train makeup and ease of adding or removing cars at connection points. Stream-lining has some practical value, but its real merit is the great appeal to the public's aesthetic sense.

In Al alloy cars the structure is riveted. Because the Al alloy has a modulus of elasticity only ⅓ that of steel, the deflection

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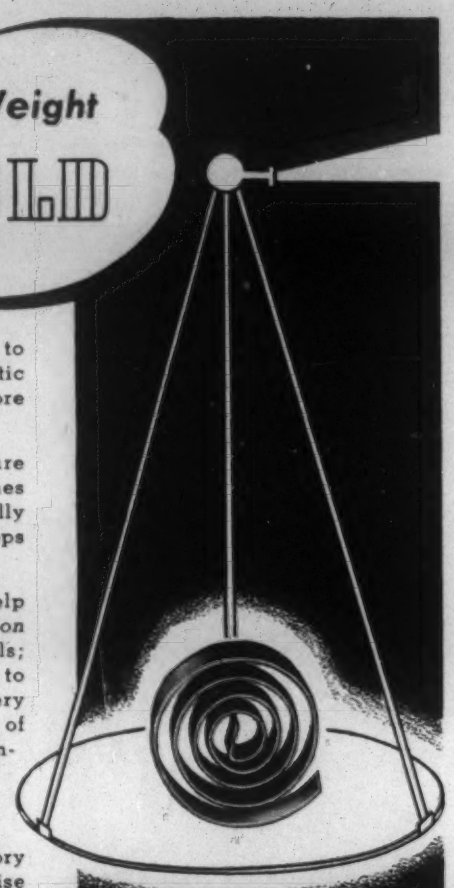

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factor must be carefully considered in design; extruded sections are highly advantageous in this respect. For certain framing members, high-strength steels are advantageously used in combination with the structural Al alloy. In the truss-frame cars, each truss member must be as carefully proportioned to the stress requirement as a member in a bridge truss. Not only the structural members, but practically all parts of the new light-weight cars are built of "new" materials, as compared with the old cars. FPP (10)

10a. Ferrous

Thermal Conductivity and Electrical Resistivity of Cast Irons (Étude sur la Conductibilité Thermique et la Resistance Électrique des Fontes) J. MARÉCHAL & J. LISTRAY. *Rev. Mét.*, Vol. 36, May 1939, pp. 240-250. Research. Thermal and electrical conductivities were determined for a series of gray cast irons with 2.73-3.47% C, 2.00-2.10% Si, 0.44-0.47% Mn, 0.66-1.56% P, 0.09-0.10% S, and 0.15-1.4% Cu and test specimens 35 and 75 mm. in diameter. Tests were also made on a second series of cast irons with 2.7% C, 2% Si, 1.2% Mn, and variable P; however, these irons were so inhomogeneous structurally that the results are questionable. At 100° C., the thermal conductivity of the gray irons varied from 0.091-0.113 cgs. It decreased with increasing temperature (tests only up to 180° C.) and increasing P. The 75-mm. diam. bars had higher thermal conductivity than the 35-mm. bars. Cu did not have a marked effect on the results. [Donaldson *(Metals and Alloys,* Vol. 10, Oct. 1939, p. MA 618 R/6), reporting thermal conductivities of high duty cast irons, found that Cu definitely lowered the thermal conductivity of irons to which it was added.—F.P.P.] The results on the second series are not reliable but indicate that the partially white cast irons have a thermal conductivity much lower than that of the gray irons. The electrical resistivity in microhms-cm. for the first series of gray irons (75-mm. diam.) varied from 97-99.6 at 20° C., 103.5-106.7 at 100° C., and 128-130.3 at 360° C. The 35-mm. bars had slightly lower resistivity. The electrical conductivity decreased with the P content. The second series with variable P had higher conductivity than the first set. Further tests showed that the electrical conductivity decreases as the size of the graphite lamellae increases. The law of Widemann and Franz on the inter-relationship of thermal and electrical conductivity is inapplicable for cast irons; reasons for this are discussed. JZB (10a)

Reinforcing Concrete with Pre-Stressed Steel Wire (Stahlsaitenbeton) A. KLEINLOGEL. *Stahl u. Eisen,* Vol. 59, Aug. 3, 1939, pp. 896-898. Practical. The main purpose in using a cold-drawn thin wire instead of ordinary reinforcing rod is to economize on steel. It is stated that a saving of steel of as much as 85% over the ordinary type of reinforced concrete construction can thus be made. Wire of 0.6 to 0.8% C content of 6 to 8 mm. diam. is patented and cold-drawn to 0.2 to 1.5 mm. diam. and a tensile strength of 420,000 lbs./in.^{2} Thin wire gives much more surface than thicker rod of similar weight and results in better adhesion between the steel and cement. A set-up for making 100-m. long I-beam sections of reinforced concrete using such reinforcing wire, is described. The wires are evenly spaced by passing them through holes in the proper templates, and stretching them tightly. Such reinforced sections have been used in building construction as a substitute for wooden beams and columns. Hamburg has a large plant for producing such reinforced concrete sections. SE (10a)

Antimony in Mild Steel. B. JONES & J. D. D. MORGAN. *J. Iron Steel Inst.,* Adv. Copy No. 6, Sept. 1939, 22 pp. Original research. The influence of Sb on the properties of steels containing 0.17% C was determined. Steels containing up to 0.69% Sb could be hot worked, but with higher Sb contents the steels became increasingly hot short. Like As and P, Sb in sufficient quantities embrittles steel, being dissolved in α Fe and stabilizing it. Steels with over 0.7% Sb are harder than steels without Sb, but have about the same tensile strength. Higher Sb steels have very low tensile strength and are seriously embrittled. Steels with a low Sb content are more susceptible to atmospheric and acid corrosion than C steel. With increasing Sb, however, the steels become more resistant. Sb contents of 0.24% do not adversely affect carburizing properties. Corrosion-resistant high-Sb cases were produced by cementation with Sb. JLG (10a)

10b. Non-Ferrous

The Thermal Conductivities of Some Industrial Alloys of Copper and Nickel. J. W. DONALDSON (Scott's Shipbuilding and Engineering Co.) *J. Inst. Metals,* Vol. 65, 1939, Adv. Copy No. 845, 7 pp. Original research. Results of thermal conductivity tests on 3 groups of industrial non-ferrous alloys are given. Group 1 consisted of 2 high-tensile brasses and 3 Al

bronzes in the cast and rolled condition; group 2 of 6 high-Ni alloys, including cast and rolled Monel metal, K-Monel metal, 2 Si-Monel metals and Inconel; and group 3 of 4 Ni-bronzes containing 5, 15, 30, and 50% Ni. Conductivity values were measured over a range from 40° to 520° C. Work in the form of rolling had little influence on the heat-conductivity values. The conductivity of all of the alloys increased with increasing temperature. In general, the alloys with Ni had the lower conductivities. A high-tensile brass had the highest thermal conductivity. Al bronze and Admiralty gun metal had the next highest. Rolled Inconel had the lowest conductivity. JLG (10b)

Use of Magnesium Alloys in the European Automotive Industry. H. ALTWICKER (I. G. Farbenindustrie) *S. A. E. Journal*, Vol. 45, Sept. 1939, pp. 9-13, 17-19. Review. Magnesium alloys are known in Europe as Elektronmetal. The number of foundries producing Mg-alloy castings in Europe increased from 13 in 1925 to 69 in 1938, with 52 in present-day Germany and Switzerland. The price of standard Elektron casting ingots dropped from 50c per lb. in 1925 to 27c in 1938. In changing to Mg alloy, costs are most favorable for castings. While rough Mg alloy castings are costlier than cast-iron this is practically offset by low machining cost. Costs of Al and Mg alloy castings are about the same, if virgin grades of each are used. Magnesium alloy die castings are frequently cheaper than Al alloy die castings. Magnesium alloy castings are 20-35% lighter than Al castings, 50-70% lighter than cast iron and 40-50% lighter than cast steel. Their excellent machinability leads to appreciable reductions in machining time and lower tool costs.

Magnesium alloys are supplied as sand, permanent-mold, and die castings; in extruded form as bars, shapes, and tubing; and in rolled form as sheets and strip. New applications have recently been developed for forgings and pressings. Tensile strength of casting alloys is 26,000-39,000 lbs./in.^{2}; yield point 7,000-16,000 lbs./in.^{2}, and elongation 2-12%. The higher values are for heat-treated alloys containing 9% Al. The mechanical properties of this type of alloy are equal to those of Al casting alloys used for similar purposes. Hardness and compressive strength are lower than with Al alloys, so that larger bearing surfaces are required for bolt heads, washers, gaskets, etc. For highly-stressed castings, the heat-treated 9%-Al castings are used. For applications involving impact stresses, alloys containing Zn and Al are used. Alloys containing Mn are easily welded. Silicon-bearing alloys are preferred for pressure-tight castings.

Aluminum is also the most important alloying element in wrought Mg alloys. Mechanical properties of Mg alloy extrusions and forgings are a function of the percentage of reduction. Other factors determining mechanical properties, particularly of forgings, are shape and design of the part and method of manufacture. The endurance values of wrought Mg alloys, as determined on standard test bars, are equal to those for high-strength Al alloys, but the former are more sensitive to edge stresses and notch effects. Therefore, transition of cross-sections in all Mg alloy parts must be blended carefully. The elastic modulus of Mg alloys is lower than those of heavier metals. In regions of concentrated loads, larger areas must be used to carry the stresses, which can be done by suitable design. Walls provided with ribs or corrugations and box-like cross-sections result in high inertia values and, therefore, are preferred. In designing castings, particular care must be taken to prevent contact corrosion and to avoid possibility of collecting water in pockets of castings or structural parts of any kind.

The largest use of Mg alloy castings in the European automotive industry is for bus and truck crank cases and transmission housings. Permanent-mold castings are used for transmission housings, brake-shoes, oil pans, oil-pumps, and bearing caps. Cast-Mg alloy die-block is used for forming sheet in drop-presses. Truck and bus wheels are made of sand-cast Mg alloy. Passenger trailer bodies are constructed of AM 537 alloy extruded shapes and sheets. In the aircraft industry, engine crank cases, wheels, landing-gear parts, steering columns control levers, engine-control housings, and tail-wheel forks are made of Mg alloy castings. Propeller blades and supports for liquid-cooled engines are press-forged from AZ 855 alloy. AM 503 alloy is best for welding, and engine and radiator cowling, fuel tanks, and oil-tanks are made from sheet of this alloy. MS (10b)

Progress in the Field of Plastic Zinc Alloys (Fortschritte auf dem Gebiet knetbarer Zinklegierungen) KARL LÖBERG. *Z. Metallkunde*, Vol. 31, Aug. 1939, pp. 279-283. Original research. Breakage or a "cuppy" condition are frequently obtained on extruded Zn alloys, in spite of low working speeds. Variations of the entrance angle effected no improvement and substitution of dies used for brass furnished no better results either. A specially-designed die of convex contour at the entrance and having a long bearing was, however, very successful. The working speed could be raised from 9 m./min. to 20 m./min. The less pronounced "glove effect" of the outer layers was proved to be the reason for the better results with the new die. The variations

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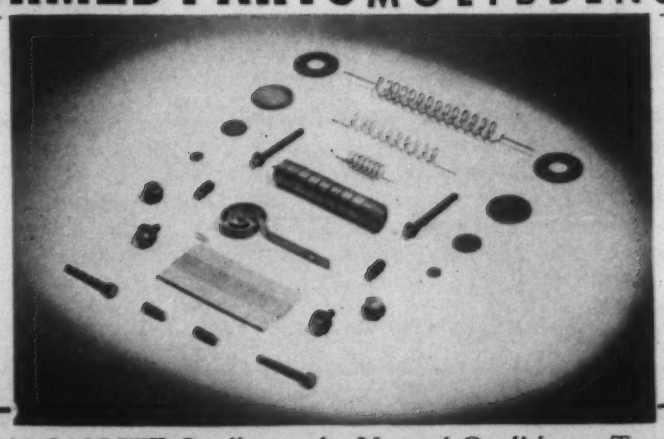

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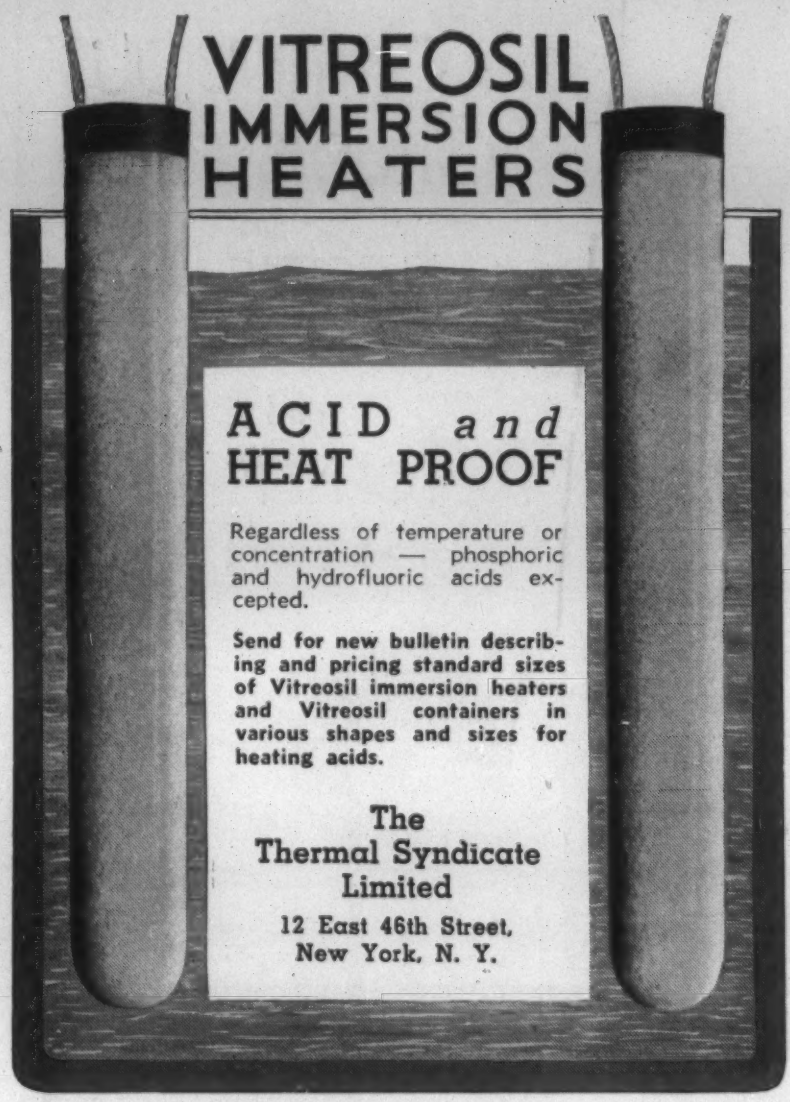

of the form of chips obtained in turning a 10% Al, 2% Cu, 0.03% Mg, remainder Zn alloy in relation to plastic deformations up to 64% are noteworthy. Up to 25%, the chip is short and brittle. Above 25% it becomes wiry and tough.

The room temperature aging in relation to plastic deformation of the same alloy was investigated by means of hardness tests. In the untreated state, the physical properties change in a manner characteristic for lattice alloys during precipitation hardening, while the cold-worked alloys—at small and medium plastic deformations—resemble cubic lattice materials. It is shown that the determination of notch-impact strength of wrought Zn alloys with higher Al contents yields more useful data than the determination of the impact bending strength of unnotched specimens. The creep resistance according to the DVM definition does not indicate the true creep strength in the case of Zn alloys. Long time tests are required for determining this property. EF (10b)

Thermal Expansion of Bearing Metals (Ueber die thermische Ausdehnung von Gleitlager-Legierungen) WALTER BUNGARDT & GUNTHER SCHAITBERGER. *Z. Metallkunde*, Vol. 31, July 1939, pp. 240-244. Original research. By means of a sensitive dilatometer of recent construction, the mean linear thermal expansion coefficients of Al-, Mg-, Sn-, Pb-Sn-, Pb-, Cd- and Cu-base bearing alloys were determined. The analyses of the 36 bearing metals investigated are given and the alloys are briefly characterized. The experimental results are tabulated. Four of the cast Al alloys showed the same expansion characteristics on repeated heating to 300° C. while 3 others had to be "broken in." The eutectic Al-Si alloys have the smallest expansion coefficients. The Mg-base bearing metals showed considerable and inconsistent expansion coefficients; some of these "inconsistencies" are attributed to the solution of the Al_3Mg_4 phase. In binary Mg-Pb alloys, the expansion coefficients gradually increase because of the falling solubility of Pb in Mg and the precipitation of Mg_2Pb. Rapid decomposition of certain unstable Mg and Al bearing alloys takes place at temperatures considerably higher than actual service temperatures. The specific composition of Sn-base babbitt was found to have practically no influence on its thermal expansion characteristics. However, if considerable amounts of Sn are replaced by Pb, a notable increase of the expansion capacity results. The data on Cd-base alloys agree with literature statements, while the values obtained on babbitts are somewhat lower. Hidnert's data on bronze were confirmed, including his observation that the addition of Sn or Pb to Cu increases the expansion coefficients. EF (10b)

10c. Effect of Temperature

The abstracts in this section are prepared in cooperation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M. The purpose of this cooperation is to make readily available complete references to the literature of this subject. The Committee does not necessarily subscribe to the statements of either the author or the abstractor.

Resistance of Steel to Repeated Tension-compression Stresses at 500° C. (Verhalten von Stahl gegen Zug-Druck-Wechselbeanspruchung bei 500° C.) M. HEMPEL & F. ARDELT. *Arch. Eisenhüttenw.*, Vol. 12, May 1939, pp. 553-562. Original research. Creep curves at 500° C. were obtained for a 0.58% C steel, a 0.14% C, 0.40% Mo steel, and a 0.56% C, 1.58% Si, 15.5% Cr, 13.3% Ni, 2.02% W steel under alternating tension-compression stresses. Comparison creep curves were also obtained for static tension and compression loading. The special apparatus with an automatic recording device, which was developed for these tests, is described. The creep rate for 10 hrs. could be determined to an accuracy of 10.5×10^{-4}%/hr. At elevated temperatures creep occurs under alternating tension-compression stresses in the same way as in ordinary creep testing, the creep rate being greater in the first few hours and then gradually declining. The course of the creep curve under alternating stressing depends on the median and maximum stressing. It is of interest that, when the median stress is zero (*i.e.* the positive and negative stresses are equal) creep still occurs. There is a lengthy discussion, with numerous diagrams, on how these results may be interpreted. SE (10c)

11 Corrosion and Wear

Chemical and Atmospheric Corrosion and Oxidation, Abrasion, Cavitation and Erosion. See also Sections 7 and 10.

V. V. KENDALL, SECTION EDITOR

The Influence of the Steel-Base Composition on the Rate of Formation of Hydrogen-Swells in Canned-Fruit Tinplate Containers.—Part I. T. P. HOAR, T. N. MORRIS & W. B. ADAM. *J. Iron Steel Inst.*, Advance Copy No. 4, Sept. 1939, 38 pp. Original research. Twenty-nine cases of tinplate typical of the plate used in Britain were obtained. This should represent a random sample of plate used in Britain containing approximately 1½ lb. tin per base box. Two cans from each lot were used in packing each of the following fruits: black currants, white cherries, gooseberries, loganberries, plums, raspberries, and strawberries. The cans were double-lacquered and all of the plate was pack-rolled. All packs were held at 35° C. and the times at which hydrogen swells occurred determined. After the cans had swelled the steel basis of each can was analyzed for P, S and Cu. Accelerated corrosion tests in citric acid were made on the basis material from swelled cans, tests being made both with and without the presence of air. The results of all observations were carefully studied by standard statistical methods. There was good

correlation between time required for hydrogen swells and accelerated corrosion tests. The mean contents of S, P and Cu of the plate were 0.061, 0.053, and 0.101%, respectively. S had no measurable influence on time of hydrogen swell. As the Cu increased and P decreased, the time for hydrogen swell increased. It is suggested that the expected life of a high-Cu (0.16-0.22%) low-P (0.03-0.045%) steel should roughly double the expected life of packs of several of the fruits. JLG (11)

Metals and Alloys Resisting Acids at Elevated Temperatures (Métaux et Alliages Résistant aux Agents Acides à Haute Température) A. M. KRAWCZYNSKI. *Chimie & Industrie,* Vol. 41, June 1939, pp. 1050-1060. Comprehensive review. The resistance to oxidation of high Cr alloys could be improved only slightly by Ni additions. Alloys with low Cr content or free from Cr gain enormously by Ni additions. There is no metal used in industry that resists boiling H_2SO_4. 95% acid has no effect on platinum up to 200° C. The acid may be concentrated to 58° Bé in lead; 0.08% Cu, 0.3-0.5% Sb or 1-3% Ni improve the resistance of lead to boiling acid up to 60° Bé. The same acid leaves antimony and silver practically unaffected. For weak solutions cast iron can be used. Mild steel resists dry sulphuric anhydride gas at high temperature as well as oils with more than 20% free SO_3. Sulphurous acid can be heated under 20 atm. pressure in Pb. Al can be used up to 400° C. for moist gas, mild steel and cast iron up to 100° C. Copper successfully withstands acetic acid in complete absence of O_2. Silver is widely used for contact with pure hot acetic acid, and Al can often be employed. Cr, Ni, and Ag are resistant to acetic acid gas. At 600° C. and 700° C. neither corrosion of Ag nor decomposition of the acid were observed. Owing to O_2 absorption the industrial use of Ag in contact with acetic acid is limited to 300-400° C.

The resistance of stainless steel to hot H_2SO_4 and acetic acid is improved by Mo, W and Ta additions. In some cases P acts favorably. Cu and Sb noticeably improve the resistance of 18/8 to H_2SO_4. The concentration of H_2SO_4 at the boiling point should not exceed 20-25% if in contact with 18/8. Al-bronze and certain Ni-Cu alloys offer good resistance to boiling acid of 55° Bé. Certain 18/8 steels with Mo additions resist oils up to 70° C. that contain over 11% free SO_3. Austenitic 18/8 alloys are resistant to acetic acid up to 10% at temperatures of 80°-90° C. With 3.78% Mo, 20.9% Cr, 10.6% Ni, the alloy shows no corrosion loss in acetic acid at 80°-90° C. over the whole range of concentrations. Alloys rich in Cr and containing Al and Si are of particular interest for acetic acid at high temperatures. In order to improve their resistance to acetic acid gas a previous heating at 600° C. in air in order to form Cr, Al and Si oxides on the surface is recommended. Si-castings show remarkable resistance to hot H_2SO_4 and acetic acid; P and S are considered generally as detrimental elements; Ni seems to improve the resistance to hot concentrated H_2SO_4. A Si content of 14-15% gives a silicon-iron highly resistant to mineral acids. Pearlitic castings with low Ni and Mo content are used for castings that are to withstand hot H_2SO_4. Castings with 12-15% Ni, 1.5-4% Cr, and 5-6.5% Cu are resistant to H_2SO_4. Another casting alloy for use with H_2SO_4 and especially acetic acid has: 0.13% C, 0.35% Mn, 4.7% Si, 30% Cr, 31% Ni, 7.5% Mo, 0.4% Cu. 48 references. RPS (11)

Observations on the Behavior of Steel Corroding Under Cathodic Control in Soils. I. A. DENISON & R. B. DARNIELLE (Natl. Bur. Standards) *Trans. Electrochem. Soc.,* Vol. 76, 1939, Preprint No. 21, 16 pp. Original research. A corrosion condition is said to be under cathodic control, if the rate of corrosion is determined by the cathodic reaction. This is the type of corrosion occurring in many soils. The anodic areas on the steel do not appreciably polarize, hence the rate of corrosion is determined by the rate at which the cathodic areas are depolarized by atmospheric oxygen. The corrosion of steel in 16 different samples of soil was determined with a cell consisting of a bakelite ring filled with the sample of moist soil. The anode was an iron disc and the cathode a screen of iron wire. The electrodes were buried in the soil about 1 cm. apart, with the cathode more accessible to air than the anode. The electrode potentials and the currents developed by the cells were measured.

The loss in weight of the anodes paralleled the value of the maximum short circuit current of the cell. Thus the corrosiveness of a soil might be indicated by this current. Measurements were also made of the corrosion potentials of the cells and the currents delivered by the cells at the corrosion potentials. (When the electrodes of a cell, having a low internal resistance, are shorted, they both come to the same potential with respect to the cell electrolyte. This is the corrosion potential.) This latter current is usually parallel to and somewhat larger than the short circuit current. In the soil between the electrodes of the cell, a membrane of corrosion products appeared, usually nearer to the anode than the cathode. It was considered to be formed by the precipitation of iron oxides by the interaction of ferrous ions (from the corrosion of the anode) migrating to the cathode and OH-ions migrating to the anode. AB (11)

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Corrosion Protection by Coatings—Metallic and Non-metallic. The field of "protective coatings on metals" is so broad that modern books on the subject encompass over 400 pages and still are forced to skimp many phases. Among the more general subdivisions on which more factual information is needed is the actual corrosion protection afforded by various coatings on different metals. Recent articles have been devoted to the atmospheric corrosion resistance of several types of metallic coatings; the corrosion behavior of zinc-coated iron in water; the relative efficacy of various paints on iron; electrodeposited and other coatings on zinc and its alloys; and special coatings on Mg alloys.

A comprehensive review, with new experimental data on the corrosion of a wide range of metallic coatings has been presented by S. G. CLARKE ("The Atmospheric Corrosion Resistance and Protective Value of Metallic Coatings," *J. Electrodepositor's Tech. Soc.*, Vol. 15, 1939, pp. 141-164; discussion, pp. 165-184). The rates of corrosion of ingot iron and of zinc in an industrial atmosphere were 100 and 25 times greater, respectively, than the rate in a dry tropical climate. In atmospheric exposure tests of sheets of Pb, Ni, Cu and Zn, the order of the corrosion resistance of the metals varied with the climate. Zn was the most corroded in all locations. Cu was less corroded than Ni in an industrial atmosphere. In a 7-yr. test in an industrial atmosphere, the order of merit of various metals was Pb, Sn, Al, Cu, Ni and Zn. Cu corroded about ½ as much as Ni. Atmospheric exposure tests of Ni coatings on Ni foil showed that bright Ni deposits lost more weight than ordinary Ni, but the bright Ni-Co alloy lost less weight. Thin Cr coatings (a few hundred-thousandths in. thick) over Ni coatings afforded little additional protection and served mainly to prevent tarnish. However, 0.0005 in. of Cr. protected steel in a 20-month exposure test. Cr tends to flake off of brass. This tendency is decreased by an undercoat of Cu, bronze, or Ni.

Composite Cu-Ni coatings have less atmospheric corrosion resistance than Ni coatings of the same total thickness. Cu coatings should give good protection to steel-work, but there is some prejudice against their use because of the fear that corrosion of the basis metal would be accelerated at discontinuities in the coating. Pb coatings have been used to protect large bridge members. Steel coated with 0.001 in. of Pb showed practically no rust after 3 yrs. of atmospheric exposure. Sprayed Al coatings gave good protection to steel and prevent corrosion at discontinuities in the coating. Steel coated with 0.003-0.006 in. of Al did not rust after 6 yrs. of exposure. Zn coatings protect the steel at discontinuities in the coating, thus the porosity of the coating is not important. Zn coatings of different types (electroplated, hot-dipped, and sprayed) all gave about the same degree of protection to steel. In an industrial atmosphere, Cd coatings gave less protection to steel than did Zn coatings; in a marine exposure, however, Cd gave more protection. Steel does not corrode appreciably when exposed to an indoor atmosphere of low humidity. Cd corroded less than Zn on exposure to a humid, enclosed atmosphere. Neither Ni nor Sn-plated steel was notably affected by this type of exposure. SO_2 is the chief constituent in the air that affects indoor corrosion. It readily corroded steel and Ni when the humidity was over 70%. The order of merit of metals subjected to an indoor atmospheric corrosion test was Sn, Cu, Zn, Cd. The order in which metals resisted staining by handling was Cr, Sn, Ni, Fe, Cu, Zn and Cd.

A common application of a metallic coating is the use of galvanized steel pipes in hot water lines. Such pipes corrode rapidly, particularly at temperatures above 60° C. and at higher pressures than normal. The reason for this was sought by GERHARD SCHIKORR ("The Cathodic Behavior of Zinc *Versus* Iron in Hot Tap Water," *Trans. Electrochem. Soc.*, Vol. 76, 1939, Preprint No. 13, 9 pp.), who measured the current developed in a corrosion cell consisting of an iron rod placed in the center of a galvanized iron pipe through which hot water flowed. At first the current flowed in a direction which indicated that the Zn was anodic, but after several hours a protective film formed on the Zn, and the direction of the current reversed, indicating that the Zn was now cathodic to (*i.e.* more noble than) the iron. The cathodic behavior of the Zn resulting from the formation of the protective film is believed to be responsible for the accelerated corrosion of iron wherever the latter is exposed. The presence of oxygen in the water contributes to the ennobling of the Zn. Also, the Zn was cathodic to iron only above 60° C.

The most familiar method of protecting iron and steel against corrosion is by painting. The corrosion protection afforded by about 50 different paints on iron was measured by H. E. HARING & R. B. GIBNEY of Bell Laboratories ("An Electrochemical Study of the Corrosion of Painted Iron," *Trans. Electrochem. Soc.*, Vol. 76, 1939, Preprint No. 24, 15 pp.), who used an electrochemical method and compared the results with those of a year's exposure to the atmosphere. The electrochemical method consists of measuring the potential of the cell, Fe/paint film/tap water/saturated KCl/HgCl/Hg, over a period of several days; it was necessary to make the measurements in a nitrogen atmosphere, as oxygen had a disturbing effect. The corrosion of the steel was indicated by a drift of the potential to more electronegative values. The paints were classified into 4 groups on the basis of the number of hrs. (up to 10 hrs.) required for corrosion to be indicated. The agreement between the electrochemical method and the results of the atmospheric exposure tests was satisfactory in 80% of the experiments. In those cases where there was a discrepancy between the 2 methods, the cause was found to lie either in an improvement or in a deterioration of the paint film on aging in the atmospheric exposure tests. Paints made with vehicles containing synthetic resins were in some cases superior to linseed oil. Primers containing 25% pigment by volume were superior, on outdoor exposure, to those containing 6% pigment by volume.

Electroplated coatings for the protection of zinc and its alloys were examined by H. BÄRMANN ("Galvanische Metallüberzüge zum Schutze von Zink und Zinklegierungen," *Z. Metallkunde*, Vol. 31, Aug. 1939, pp. 281-287). Coatings of copper, brass, 60/30 Zn-Cu, Ni and Cr are discussed. Corroded samples provided with Cr platings of 2, 10 and 20 μ thickness, and with different intermediate layers, after exposure to running water or to atmospheric corrosion for various lengths of time are shown in photographs. The tests largely confirmed the minimum thicknesses of coatings specified by the A.S.T.M. Sufficient corrosion protection of Zn and its alloys by electrodeposited coatings is secured only with sufficiently thick and dense deposits. Because of porosity, chromium plates of even 20 μ thickness do not offer effective corrosion protection if no intermediate layers are employed. Good results were obtained with a combination of 3 layers of 6 μ of Cu, 7 μ of 60/30 Zn-Cu and about 1 μ of Cr on top.

Zinc alloys are also satisfactorily protected against corrosion by certain surface treatments, according to recent studies by KURT BAYER ("Korrosionsbeständigkeit von Zinklegierungen," *Ibid.*, pp. 262-264). Salt spray tests on 3 Zn alloys and electrolytic zinc in the unprotected and in the "chromatized" state showed material improvement in all cases through the chromate treatment. Potential measurements on elements using zinc, Zn alloys, copper, iron, aluminum, brass and Mg alloys showed the behavior of Zn alloys to be similar to that of the metal in acid, alkaline and neutral solutions. The formation of local elements in Zn alloys can be effectively counteracted by chromate or phosphate treatments. According to E. RAUB & M. WITTUM ("Oberflächenschutz von Zink und Zinklegierungen," *Ibid.*, pp. 269-278) excellent protection is afforded by either the "Cronak" (dipping in H_2SO_4-bichromate solutions) or the Schulein (a.c. electrolysis in chromic acid solution) process. Neither Bayer nor Raub & Wittum have a high regard for the general value of electroplated metal coatings on Zn alloys.

Essential to the wider application of still another potentially useful metal, magnesium, has been the development of special coatings to enhance its corrosion resistance ("Corrosion and Practice of Magnesium Alloys," *Light Metals*, Vol. 2, Sept. 1939, pp. 313-316). Since Mg borates and phosphates are insoluble in water, they have been recommended as coatings for the protection of Mg alloys against corrosion. Silicate treatments have been advocated for the same purpose, with the additional claim that the physical properties of the alloys may be thereby improved. The chromate (usually dichromate) treatment is well known and much used. There are many variations of the chromate process, but all of them result in the deposition of a thin film which has the double property of furnishing some corrosion resistance as well as forming a good base for painting. A selenium treatment has also been recommended in which selenious acid or a soluble selenite is used in conjunction with a corroding salt such as NaCl. The selenium films are, to some extent, self-healing in the presence of moisture. The chrome-phosphate process, which has been used to some extent, utilizes sodium dichromate and monobasic sodium phosphate in a water solution.

Unlike Al and its alloys, Mg cannot be anodically oxidized by the usual methods. An oxide coating can be put on, but it is not particularly adherent nor impervious to salt solutions. Electrolytically deposited fluoride coatings have been recommended for atmospheric corrosion resistance. The coatings are deposited in a hydrofluoric acid bath, making the metal the anode. Such coatings may also be applied by the use of water-soluble fluorides instead of hydrofluoric acid. The tendency of rivets to become localized areas of severe corrosion, as well as the desirability of covering rivet heads for aerodynamic reasons in airplane structures has led to the application of a strip sealing material which has an Al- or Mg-backed thermoplastic adhesive that covers the rivets. Heat and light pressure are sufficient to fasten the foil firmly to the riveted structure. Owing to the very wide variety of liquid fuels and oils, considerable research must be done before the best Mg alloys and the most satisfactory coating materials can be recommended for specific applications in fuel or oil tanks and containers. X (11)

books

Engineering Metals and Alloys

ENGINEERING PHYSICAL METALLURGY. *By Robert H. Heyer. Published by D. Van Nostrand Co., New York, 1939. Cloth, 6¼ x 9¼ in., 549 pages. Price $4.50.*

This excellent book will probably enjoy wider use than the author intended. The preface states that the volume is designed to aid those making their first acquaintance with metals and alloys and that the treatment is simple and adaptable to the instruction of non-metallurgical students. We see no reason why the book could not serve also as a first text for metallurgical engineering students and as a starting point for the graduate non-metallurgical engineer and executive desirous of acquiring more knowledge of metallurgy.

The book treats of metallic materials and their processing, dealing chiefly with mechanical properties and structural effects rather than with equipment and production factors. Applications are related to properties, and the latter to structure wherever possible. About one-third of the book is concerned with the properties, treatment, and welding of non-ferrous metals and alloys, the rest of the book to similar aspects of steels, alloy steels, steel castings, cast iron, stainless and tool steels. Confinement of subject matter in each case to the "metallurgical" rather than operational factors has permitted the author to be more intensive than if he had to allow space for detailed descriptions of equipment and methods. Thus, the material in each chapter is surprisingly complete and up-to-date. The author's background, a combination of pedagogical and industrial experience, has undoubtedly contributed largely to the lucidity and authenticity of presentation. A large part of the material in each chapter is taken from articles, papers and books published in this country during the last 5 years; the references, given at the end of each chapter, include some as late as April 1939.

The book is definitely not a handbook and its only value to the metallurgical expert will be to bring him up-to-date on important new knowledge in other fields than his own. But for everyone else interested in metals, the volume will be an ideal medium for acquiring an accurate, fundamental understanding of general industrial metallurgy.—FRED P. PETERS.

Cast Iron Micrographs

METALLOGRAPHIC ATLAS (Atlas Metallographicus) Vol. 2, Parts 7 and 8. *By H. Hanemann & A. Schrader. Published by Gebruder Borntraeger Verlagsbuchhandlung, Berlin, 1939. Paper, 7¾ x 11¼ in., 85 pages. Price 21 RM.*

These parts complete the cast iron section of the Atlas, of which parts 1-4 came out in 1936, and 5 and 6 in 1938. The micrographs and accompanying tabulations of composition and properties of these parts relate chiefly to heat-treated irons and to chilled irons. An index to the whole of the volume on cast iron is included.

The micrographs and their reproduction are of the same high order of excellence as in previous sections of the Atlas.—H. W. GILLETT.

Open Hearth Design

THE OPEN HEARTH FURNACE. Vol. 3. *By W. C. Buell, Jr. Published by Penton Publishing Co., Cleveland, 1939. Cloth, 6¼ x 9¼ in., 308 pages. Price $4.00.*

This volume, which completes the engineering appraisal of correct open hearth furnace design, deals with auxiliary apparatus, slag pockets, regenerators, flues, waste heat boilers, controls, etc. Particular attention is paid to volume and velocity of gas flow. The treatment is similar to that in the preceding volumes. The series as a whole is indispensable to the open hearth operator, who will thumb its pages many times.

The book closes with the suggestion that when the furnace has been properly designed or rebuilt to the most feasible approach to best design, and everything adjusted for maximum economy, the installation of automatic controls that will do the right thing at the right moment (instead of depending on the melter's judgment) is advantageous if they really perform such functions. Stress is laid on the importance of indicating instruments and while the need for adequate methods of temperature measurement is strongly stated, the various attempts now being made to meet this need are not described.—H. W. GILLETT.

Metallography Textbook

PRINCIPLES OF METALLOGRAPHY—4TH EDITION. *By R. S. Williams and V. O. Homerberg. Published by McGraw-Hill Book Co., New York, 1939. Cloth, 5¾x8¼ in., 339 pages. Price $3.50.*

This is a text book intended for engineering students who are not specializing in metallography, but who need some knowledge of it in their professional work. This edition has had extensive revision. No attempt is made to go exhaustively into engineering properties and uses, though these matters are not neglected. The main purpose, to bring out the importance of the structure of a metal and to show how the structure may be made visible for evaluation, is well accomplished.

The contents are pleasingly up-to-date, and the brevity necessary in so small a text book seldom leads to misapprehension, even by a reader to whom the material is wholly new. Few elementary text books are free from criticism on this score, but the only one of importance on this volume is that the discussion of the McQuaid-Ehn test does not make clear that true grain-coarsening propensities are not necessarily evaluated by the test.—H. W. GILLETT.

Other New Books

CHROMIUM IN CAST IRON. *Published by Electro Metallurgical Co., New York, 1939. Paper, 8½ x 11 in., 48 pages. Free to those interested.* More than a sales catalog—covers production, treatment, properties and uses of chromium cast irons.

TRANSACTIONS, AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, VOL. 135, IRON AND STEEL DIVISION. *Published by American Institute of Mining and Metallurgical Engineers, New York, 1939. Cloth, 6x9¼ in., 590 pages. Price $5.00.*

THE FIELD OF POWDER METALLURGY — AND BIBLIOGRAPHY. *Published by Metals Disintegrating Co., Elizabeth, N. J., 1939. Paper, 5½x 7⅝ in., 48 pages.* Free to genuinely interested persons. Remarkable for its objective treatment and almost complete freedom from advertising material. Contains 20 pages on applications and limitations of powder metallurgy and an evidently complete 20-page 338-reference bibliography.

TRANSACTIONS, AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, *Vol. 133, Institute of Metals Division. Published by American Institute of Mining and Metallurgical Engineers, New York, 1939. Cloth, 6x9¼ in., 355 pages. Price $5.00.*

MACHINING OF LIGHT METALS (Zerspanung der Leichtmetalle). *By E. H. A. Wallichs and R. Wallichs. Published by Carl Hanser, Munich, 1939. Paper, 5½x8¼ in., 102 pages. Price 2.65 RM.* Practical discussion of tool materials, angles, speeds, feeds, etc., for machining the Al and Mg alloys used in Germany, of which the compositions and properties are listed.

CURRENT news

Southern Blast Furnace and Raw Materials Ass'n—First Meeting

The Southern Blast Furnace and Raw Materials Association met at the Thomas Jefferson Hotel in Birmingham, Ala., on Friday evening, Nov. 10, 1939. As this was the first meeting since the society's inception last August, this was a "get acquainted" meeting, with C. L. Bransford, district manager of the Republic Steel Corp., and the association's first president, being host to the group at an informal gathering before a "dutch treat" dinner. The principal speaker of the evening was J. E. Urquhart, general manager of The Woodward Iron Co., who described the recent air conditioning installation on one of his company's furnaces. Considerable discussion followed Mr. Urquhart's interesting and complete portrayal of this pioneering development in blast furnace practice.

In his opening remarks, Mr. Bransford traced briefly the history of the society. He pointed out that the Chicago District and the Eastern States Blast Furnace and Coke associations have served a useful purpose in the industry for many years, and that it was fitting and proper that there should be a similar organization in the South. However, since the district around Birmingham furnishes all the raw materials necessary for the production of pig iron, this new society includes not only blast furnace and coke oven operators, but also ore and coal miners who are interested in furnishing the raw materials needed in the manufacture of this product.

The Association already has over 80 members, although so far it has limited its membership strictly to operators in the Southern District. It is expected that this membership will be considerably increased after the success of the first meeting.

Officers of the society are: C. L. Bransford, president; J. E. Urquhart, vice-president; Francis Crockard, secretary-treasurer; directors, G. M. Harris, C. S. Lawson, Fred Osborne, J. M. Spearman, A. G. Overton, Ben Davis.

New Officers of Meehanite

Present officers of the Meehanite Research Institute of America, Inc., were re-elected at the annual meeting of the organization held in Detroit, Nov. 1, 2 and 3. Officers include: O. Smalley, president of the Meehanite Metal Corp., Pittsburgh, president; H. B. Hanley, foundry manager, American Laundry Machinery Co., Rochester, N. Y., vice president; F. M. Robbins, president, Ross-Meehan Foundries, Chattanooga, Tenn., secretary-treasurer.

New Sales Manager for Lebanon

Warden F. Wilson has been appointed general sales manager for Lebanon Steel Foundry, Lebanon, Pa. He resigns his position as Pittsburgh district manager of American Steel Foundries.

Mr. Wilson has been identified with the steel casting industry since his graduation in 1925 from the University of Illinois, when he joined American Steel Foundries as a special apprentice at its Indiana Harbor, Ind., Works. In 1928 he was appointed night superintendent, and a year later advanced to assistant to the works manager, holding this position until his promotion and transfer to Pittsburgh as manager of Pittsburgh Works of the American Steel Foundries.

A thesis on the Welding of Cast Steel won for Mr. Wilson a degree of Professional Mechanical Engineer from the University of Illinois in 1937. He is a member of the A. S. M. E., the Engineers Society of Western Pennsylvania, the A. F. A., the Railway Club of Pittsburgh, and the University Club of Pittsburgh.

Steel in Use in Nation—1,130,000,000 Tons

The amount of steel in use in the United States rose to a new high level during 1938, amounting to approximately 1,130,000,000 tons at the close of the year, as estimated by the American Iron and Steel Institute. Included in that estimated tonnage is the amount of steel in the capital goods of the nation such as buildings, bridges, machinery, railroad equipment, ships and the like, and also the steel in automobiles, house furnishings and other consumers' goods.

Since 1900 the amount of steel in use in this country has increased nearly 17 times as fast as the nation's population, with the result that the amount of steel in use per capita in 1938 was 650 per cent above the level of 1900. The increase is an indication of the rise in living standards.

Nearly 19,500 lbs. of steel were in service in 1938 for every man, woman or child in this country, as against 2600 lbs. per capita in 1900, and 18,100 lbs. in 1937.

An important factor in increasing the stock of steel in use in the country has been the increase in the average life of steel in recent years. At the present time the useful life of all the different kinds of products made from steel is estimated to average about 35½ yrs. By comparison, in 1920 the estimated life was 23 yrs.

The Air Conditioned Blast Furnace

Increase of output, lower consumption of fuel and greater uniformity of product were cited today by L. Logan Lewis, vice president of Carrier Corp., Syracuse, N. Y., as the principal advantages of blast furnace air conditioning. In addition, the blast furnace superintendent need no longer be a weather prophet. Speaking before the Industrial Air Conditioning session of the Eastern Air Conditioning Conference at Lehigh University, early in November, Mr. Lewis told the story and results to date of the air conditioning plant recently installed at the Woodward Iron Co. plant near Birmingham, Ala.

"On a maximum day," he said, "the Woodward dry blast plant prevents more than 30 tons of water from entering the furnace. Lowering moisture in the blast reduces the amount of coke which must be burned for each ton of iron produced and increases the total output which can be obtained from a furnace." Mr. Lewis then reviewed the history of the "dry blast," and James Gayley's experiments with refrigeration.

"A modern installation was recently made at the Woodward Iron Works," he added. "The furnace is a medium sized one, having an output of 400 to 550 tons per day of merchant iron (pig) on a metallic yield of approximately 36%. The wind required is 45,000 to 50,000 c.f.m. A moderate dewpoint of 40 deg. (slightly less than 3 grs. per cu. ft.) was selected as the most practical. Refrigeration is supplied by 53-9-9 turbine driven Carrier centrifugal machine, doing 520 tons of work in cooling 1200 g.p.m. of water."

"The dry blast plant was put in operation in the latter part of June. The response of the furnace to drier wind was immediate and impressive. Burden was promptly increased. A noteworthy reduction in coke per ton of iron followed promptly and the silicon content of the iron also responded to the lowered moisture content. . . . One grain per cu. ft. accounts for about 48 lbs. of coke per ton of iron; a little more than six grains, therefore, about 300 lbs. of coke per ton of iron."

"This tangible," he said, "plus that of increased production is of at least sufficient magnitude to cover more than the operating and maintenance costs of the dry blast plant. Of vital interest to all, therefore, is the value of the velvet in the form of such intangibles as regularity and the power to produce at will the quality or kind of iron desired free from krish and scruff and to hold these qualities within narrow limits."

Ferromanganese from Cuban Ore

The United States' annual capacity for the production of ferromanganese, an essential in steel manufacture, was increased by 30,000 tons when the Sloss-Sheffield Steel & Iron Co. recently launched a new ferro manufacturing program. Approximately equal to the amount of ferromanganese now being imported, this increase is significant at a time when shipments from abroad face mounting wartime dangers, it was pointed out. U. S. imports in 1938 were 26,258 tons, and in 1937, 25,599 tons. The major portion in 1938 was imported from Norway, followed by Holland and Czechoslovakia.

The ferromanganese to be manufactured by Sloss-Sheffield will be made from manganese ores shipped from Cuban deposits. Ferromanganese, made from manganese ore, is necessary as a deoxidizer and desulphurizer in the manufacture of steel. About one ton of ferro is needed in making 160 tons of steel, it is said.

Additions to Battelle's Staff

Don L. Winchell has become a research engineer on the staff of Battelle Memorial Institute. Mr. Winchell, a graduate of Denison University, has been previously employed in metallurgical work at the Canton and Massilon works of the Republic Steel Corp., and as a research assistant with the Timken Steel & Tube Co. At Battelle he will be engaged in research in process metallurgy.

Robert R. Adams, a graduate in chemical engineering of Antioch College, recently joined the technical staff of Battelle. He has been assigned to research in process metallurgy.

R. S. MacPherran Retires

Ralph S. MacPherran, chief chemist of Allis-Chalmers Mfg. Co., Milwaukee, for many years and identified with the iron and steel industry for nearly 50 yrs., is retiring from active service with his company. According to an announcement by Vice President William Watson of the company, Harold J. Stein, research engineer of the manufacturing department, has been appointed director of research, chemistry and metallurgy of the Allis-Chalmers manufacturing department, now bringing all these activities under one head. His assistant will be J. T. Jarman.

Mr. MacPherran is especially noted as an outstanding metallurgist in the field of gray iron and has long been active in many technical societies connected with his profession. In 1931 he was selected to receive the coveted J. H. Whiting gold medal award of the American Foundrymen's Association. Aside from several years with the Illinois Steel Co. right after being graduated in chemistry at the University of Michigan, he has been with Allis-Chalmers since 1895, having started with the old E. P. Allis Co. As a result of his continuous valuable investigations of gray iron he has acquired an international reputation.

"Powder-Braze"—A Brazing Alloy in Powder Form

Much interest has been created in the welding and brazing field by "Powder-Braze," a recently developed low melting point alloy powder which is especially suitable for joining non-ferrous metals and alloys such as copper, bronze and brass, according to *Metal Powder News*. The melting point is relatively low; the molten alloy flows freely and penetrates deeply, giving tough, malleable joints. The alloy brazing powder is applied by heating the joint to a low red heat and permitting the powder to flow from the spouted can in which it is packed. The powder can also be finished compressed into the shape of rings, washers, and shims for insertion between joints before applying heat either in torch, electrical, or furnace brazing.

Battelle's Technical Advisor in Physical Chemistry

Edward Mack, Jr., former head of the department of chemistry at the University of North Carolina, has been added to the supervisory staff of Battelle Memorial Institute, Columbus, Ohio. The appointment of Dr. Mack, according to an announcement by Clyde E. Williams, director, has come as a result of increased activities in the application of physical chemistry to the Institute's varied research program.

Dr. Mack will act as technical advisor in physical chemistry to the sponsored industrial projects, and in addition will correlate the Institute's fundamental research work. He is co-author of a standard text on physical chemistry and an associate editor of the *Journal* of the American Chemical Society.

Lead-Bearing Stainless Steel

Lead-bearing stainless and high-alloy steels will now be produced by virtue of licenses granted to the Allegheny Ludlum Steel Corp., Brackenridge, Pa., and the Carpenter Steel Co., Reading, Pa., under the "Ledloy" patents of the Inland Steel Co., Chicago. The Allegheny Ludlum Steel Corp. has been granted a license with the right to sub-license other producers in the stainless field, and this license is exclusive with the exception of the Carpenter Steel Co.

Powder Metallurgy at M.I.T.

An indication of the rapid growth of interest and activity in the field of metal powders is the fact that at the Massachusetts Institute of Technology 24 students are registered for the lecture course in powder metallurgy.

Free Service Department

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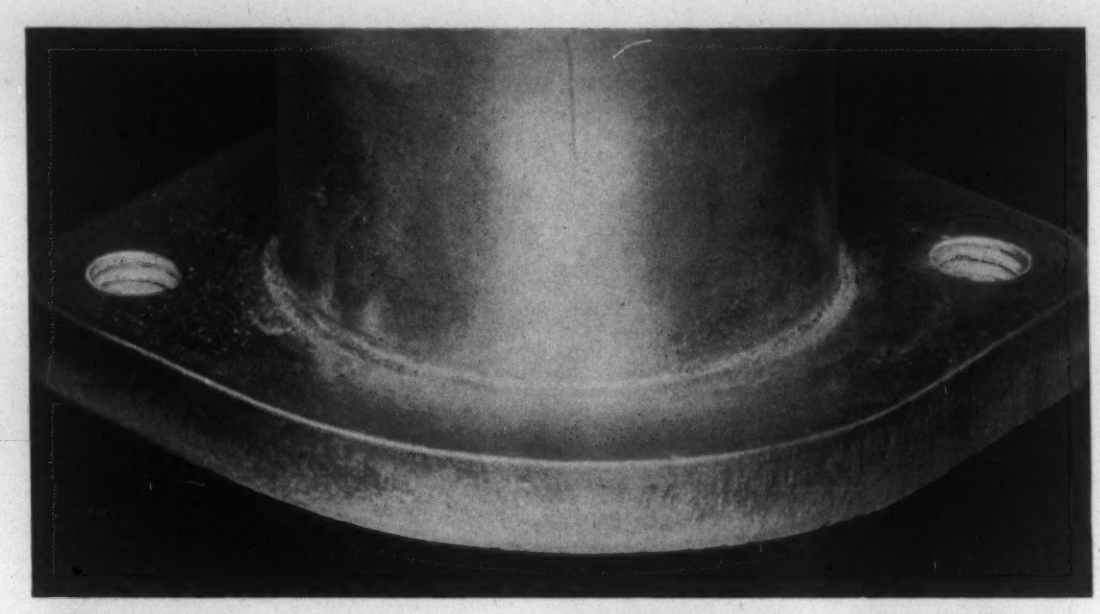

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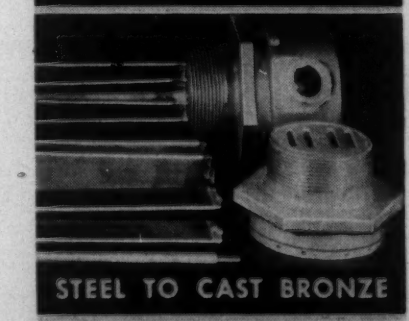

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Anaconda Sales Company.....MA 689
Armstrong Cork Company.....A 17

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Brown Instrument Company.....A 14
Buehler, Adolph I......MA 726

Callite Products Division Eisler Electric Corp....MA 729
Carborundum Company, Refractory Division Inside Back Cover
Carnegie-Illinois Steel Corporation.....A 2, A 3
Chicago Flexible Shaft Company.....MA 702
Climax Molybdenum Company Insert between pages 390 and MA 687
Columbia Steel Company.....A 2, A 3, MA 700

Dempsey Industrial Furnace Corporation.....MA 710
De Witt Operated Hotels.....MA 727
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Driver Company, Wilbur B......MA 729
du Pont de Nemours & Company, Incorporated, E. I. R. & H. Chemicals Department.....MA 688

Electric Furnace Company.....MA 692, MA 708
Electro Metallurgical Company.....A 5

Fitzsimons Company.....A 16
Foxboro Company.....A 6, A 7

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Handy & Harman.....MA 735

Illinois Testing Laboratories, Inc......MA 708
International Nickel Company, Inc.....A 18, MA 693

Johns-Manville Corporation.....A 9, MA 706

Kemp Manufacturing Company, C. M......MA 711

Leeds & Northrup Company.....MA 696

McKenna Metals Company.....MA 703
Minneapolis Honeywell Regulator Company.....A 14
Monarch Steel Company.....A 16

New Jersey Zinc Company.....A 20
Nitralloy Corporation.....MA 731
Norton Company.....MA 707

Page Steel & Wire Division, American Chain & Cable Company, Inc......MA 715
Pennsylvania Salt Manufacturing Co..MA 720, MA 721
Pike & Company, E. W......MA 726
Pittsburgh Lectrodryer Corporation.....MA 706

St. Joseph Lead Company.....MA 691
Scomet Engineering Company.....MA 728
Scott Company, Henry L......MA 724
Spencer Turbine Company.....MA 705

Taylor Sons Company, Charles.....A 4
Thermal Syndicate, Ltd......MA 730
Timken Roller Bearing Company, Steel & Tube Division.....A 8
Titanium Alloy Manufacturing Company.....MA 699

Union Carbide and Carbon Corporation.....A 5
United States Steel Corporation.....A 2, A 3, MA 700
United States Steel Products Company A 2, A 3, MA 700

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Wilson Mechanical Instrument Company, Inc....MA 724

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